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IN WHAT ORDER OUGHT COURSES IN SCIENCE TO BE INTRODUCED INTO THE HIGH SCHOOL CURRICULUM?[1]

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It would be difficult to speak of the order of the courses in science without taking into account the subject matter of the courses and the method of their presentation, therefore, I shall treat my topic in a broad way. In order to discuss the arrangement of courses intelligently, it will be necessary first to consider what the present conditions and tendencies are, and then to consider what principles should govern in planning the sequence of courses.

The present arrangement of courses in the great majority of high schools where four years' work in science is given, is as follows: physiography and physiology in the first year; biology, or botany and zoölogy, or botany, or zoölogy the second year; physics the third year; and chemistry the fourth year. Expediency has probably had much to do with determining this arrangement; size of classes that can be handled, cost of laboratories and expense of running them, college entrance requirements, and requirements in mathematics are some of the leading factors which have had much to do with determining the order of the courses in science, rather than pedagogical fitness. Variations from the order given above are found here and there. Within the last few years there has been a tendency to transpose the positions of physics and chemistry, putting chemistry in the third year and physics in the fourth. Some schools have introduced general science courses into the first year in place of physiography.

But probably the most important element portending future adjustments rather than present changes comes from the demand for the inclusion of applied sciences in the curriculum, more particularly courses in domestic science and in agriculture. Courses

[1]Read at the High School Section of the Illinois State Teachers' Association, Dec. 29, 1910.

in domestic science are now given in perhaps a majority of high schools, but courses in agriculture are being adopted more slowly probably because of the greater difficulty of satisfactorily presenting the subject in the high school.

The sentiment for the practical in science is increasing very rapidly—far beyond the original idea of the introduction of courses in domestic science and agriculture. This is best seen in Chicago where two-year vocational courses are being introduced into the schools. In order to enrich these courses there has come a demand for the reorganization of the so-called pure sciences and an enlargement of the industrial or applied phase of each subject—and to make them available for the short course pupils the applied work must be given at the beginning of the course in each department rather than at the end of the course. This is putting the cart before the horse with a vengeance. However, teachers are promised a good deal of latitude in planning this work, and if they are wise, it may prove a great benefit and no harm by making the entrance to the course more interesting to the pupil and in closer touch with his life, while preserving the scientific character of his work by making it an introduction to science rather than something apart from it. There is great danger, however, that this may not be done successfully and in the end too much of the practical without a foundation in pure science cannot but be harmful to the best interests of science. Illustrations of this tendency may be seen in very many schools which have introduced domestic science without coördinating it with other departments of science in the school. In fact, in most cases these courses have been introduced without a thought that any other department might greatly strengthen the work. The same is true of agriculture, which is too often treated as a distinct department having no relation to the pure sciences, when in fact any study of agriculture which is not based upon knowledge to be obtained from the pure sciences must be extremely superficial and misleading.

Let us now consider the principles which ought to underlie and govern the arrangement of courses in science, for surely something better than expediency or chance should determine this arrangement. I have formulated five propositions, about the truth of which, as fundamental to the choice of subject matter and the arrangement of courses in science, there can be little doubt, yet from which we are often far separated in actual practice. Allow me to state and discuss these propositions briefly.

My first proposition is that courses ought to be planned and arranged primarily with reference to the needs of the pupil rather than with reference to the development of the course itself. It would seem absurd that any other line could be taken, yet all the science courses at the present time are built up as unit courses with a well rounded development of the subject as the primary object. The inference has been that the pupil's needs and a full development of the subject are identical. But this is by no means true, especially when we find that courses have been made more and more technical and scientific and the subject matter remote from the life and experiences of the pupil. That this is true, no one acquainted with high school science can deny. It is one of the chief causes of dissatisfaction with science in the high school at the present time, and a chief reason for the demand for applied science. College entrance requirements and the attitude of the colleges and universities have also had much to do with this, each department demanding special preparation for its work, forgetting that interest and ability to do things are more important equipments for college students than the acquisition of facts for the purpose of passing entrance examinations. But the attitude of the colleges is happily changing very rapidly toward allowing the high schools entire freedom in planning the curriculum. Another factor entering into this tendency to unit development of courses is the attitude of the teachers of science. Here again the attitude of the colleges has been the determining force. The training in the college and university is technical and intensive. There are usually no broad courses intended to give students, especially those intending to teach, a broad outlook upon science, nor courses to consider problems peculiar to teaching science. It is no wonder then that teachers of science in the high schools try to build up their departments along technical lines. It is significant, as emphasizing the truth of this situation, that invariably the youngest teachers, just out of the university, are most zealous in this way.

Granting now the truth of my first proposition, my second naturally follows from this, that the courses in science in any particular school ought to be determined both as to subject matter and arrangement by two factors—the development of the pupil, and the general character and occupations of the people of the locality. In other words, the curriculum in science ought to be considered as a whole and not as a series of units. It ought to be progressive and suited to the locality.

At present the four courses in science, physiography, biology, physics, and chemistry, are four units, each a kingdom to itself, and their development of science as a whole comes rather as an incident than as a plan. Their position in the curriculum is based more on expediency than on their relation to an orderly development of science. There has been too much exclusiveness in the various departments of science. Teachers of science above all others ought to be free from bias and prejudice, and glad to help along the cause of science as a whole, but as a matter of fact they are as zealous in defense of their own particular department as was formerly the preacher in defense of his sect. Perhaps this is the reason that teachers are so often not consulted about changes in the curriculum, and these changes brought about by outside influences. There is no doubt that this conservatism of teachers, which tends to resist proposals of change or reform, often is the cause of extreme action when action finally does come. In an ideal situation the teachers of all departments of science, both of the pure and the applied, would meet together and plan the general character of the courses in science, leaving details to be worked out by the department. In this scheme there would be no repetition, and likewise there would be no gaps. Preparatory work needed for applied sciences would be provided for and there would be harmonious and orderly development of science from first to last with emphasis laid on whatever phase of science the local surroundings of the school demanded. This is no idle dream, but a wholly practical solution easily possible of achievement.

My next proposition is less general in scope. The first year of science ought to be preparatory and its material ought to be so far as practicable within the experience of the pupil. Much has been said about first year science and I do not propose to enter into the discussion at length. No one will deny my proposition, but there may be disagreement as to just what is preparatory. However, some of the qualities of a preparatory science may be agreed upon. It should make connection with the experiences of the first year pupil and be built upon facts in the pupil's own experience and interests. It should make clear certain fundamental principles which the student needs for advancement in any science. It should not be a series of more or less unconnected experiments, but should have some central theme to give purpose and orderly development.

My fourth proposition is that the applied sciences, such as

agriculture, domestic science, and others of like character, ought to follow preparatory courses in science. This proposition would also seem axiomatic, but nevertheless it is common practice to arrange these courses independently of other courses in science and often even start them in the first year of the high school. This is a great mistake, both pedagogically and as a business arrangement. The courses in pure science can and ought to be made strictly preparatory to the applied science given in the school and thus save both time for the pupil and expense for teachers and laboratories, giving at the same time a better training for the pupil. By preparatory science, I include two ideas: first, those pure sciences which are foundational for the applied science should precede or accompany the work in applied science; secondly, these preparatory sciences should use the material of the applied science for the laboratory and for illustration. For example, courses in botany, zoölogy, and chemistry may prepare for agriculture by using for material for the laboratory and demonstration things within the experience of the farmer's boy, relating the study to the phenomena of the farm. This can be done without detriment to the scientific value of the training and at the same time give a return of vastly greater interest and value to the student. In the same way courses in other applied sciences may be anticipated and their value greatly augmented. It cannot be done, however, unless there is concerted action by all departments of science.

My fifth and last proposition is that there is too much scattering of fire in science curricula by short courses. I would eliminate all half-year courses except in the first year where the requirement of physiology makes full year courses impracticable. The half-year course gives a sense of hurry, incompleteness, overcrowding, and tends to indigestion in the pupil and the killing of interest. So-called courses in biology consisting of a half year of botany and a half year of zoölogy are a serious mistake. Better work, better training, and a better comprehension of life phenomena can be had with a full year of either botany or zoölogy than in the half year of both, for the same fundamental laws of life are found in both. If the school cannot afford to give full year courses in both, then take one of them and give the attention that was spread over the two to this one. This idea that pupils must have a taste, at least, of a great many subjects is slowly giving way. Educational training should result in a disciplined mind and ability to do things. Brief courses

will not give this result; there must be time enough spent on a subject to give the pupil a grasp of the subject—time enough to gain that power that comes only from mastery. Science has not yet come into its own. The so-called "scientific" courses offered in the curricula of many schools are scientific only in name. The proposed science group of studies now being considered for the high schools of Chicago is a step in the right direction, with its six years of required work in science and three semesters' work offered in each of the four departments of science. The curriculum in science should give opportunity for forty to fifty per cent of a pupil's work to be taken in science if applied sciences are included, especially if agriculture is given. This is not too much for a symmetrical development of the pupil, providing the rest of the pupil's course of studies is well selected.

It is time now to consider the course of study, though what I may have to say can only be tentative and point the way. The real course must be adapted to the local conditions of the school.

I have already intimated that the first year's work in science should be preparatory in character and based on material within the pupil's experience. Since physiology is required for ten weeks, at least, it will be the part of wisdom to make provision for it in the plans, and make it a component part of the scheme. I would give a half year to the subject and devise a laboratory or demonstration course to accompany it, consisting of experiments to make clear the fundamental principles of science underlying physiology rather than the technical experiments immediately concerned with the function of the body. Such a course has more meaning and interest to the pupils and is preparatory for work to follow. The emphasis of the text-book work should be placed on sanitation.

The second semester's work may be an extension of the work in physiology with more of general science in the laboratory course or physiography may now become the dominant note—taking physiography in a broad sense. The main features of such a course would center around the atmosphere and water and the soil, including the origin of the soil and the relation of plants and animals and physical agents to its formation and transportation. Botany, taken also in a broad way, may give the central theme for the second semester's work in science. In this case plant relations would be the dominant note—their relations to each other, to the soil, and to man's welfare. The first year's work in science would then consist of physiology and gen-

eral science, or physiology and physiography, on physiology and plant relations, all to be given in a broad way with a laboratory course which shall explain fundamentals rather than technical relations.

In the second year botany or zoölogy should be begun in the regular courses but pupils who are to specialize in agriculture or domestic science should have an opportunity to begin chemistry either in the second year as a second science or in the third year if chemistry is coördinated with the applied science. Chemistry in any case should precede physics, because it is more fundamental. Those parts of physics needed in other departments should be developed in the first year's work in science. All applied science should be given in the later years of the curriculum, never earlier than the third year.

In closing it may be well worth while to give a moment to the new science group proposed by the principals of the high schools of Chicago for the new curriculum and recently adopted by the Board of Education of Chicago. It must be understood that this science group is only one of some eleven groups of courses from which pupils are to make their selection by groups. The first year's work is to include physiology a half year and physiography a half year. In the second and following years there are to be offered one and one half years each of botany, zoölogy, physics, and chemistry and a year of physiography. A half year of each of the first four is to be of a practical or applied nature. The student on reaching the second year may choose between the biological and the physical sciences. If he chooses the biological, he will take three years' work in these sciences and two years of the physical. If he chooses the physical, he will take three or four years of the physical and one or two years' work in biological science. In any event, he must have six years of science.

So far as I know this is the first time any secondary school has given systematically such opportunities in science. In any scientific course of studies, if it is to be worthy of the name, there should be opportunity for a second year's work in, at least, one physical and one biological science. There is no good reason why opportunity for advanced work should be given in business courses or in language courses and denied in the science courses. Science plays a large part in the affairs of man and should be given liberal treatment in any scheme of education. It is time for educators to throw off the narrow views of educa-

tion that have hampered the schools so long and be more open-minded toward educational problems. Such an attitude in educational affairs would go a long way toward solving some of the problems of life which are vexing us to-day.

LARGE APPROPRIATIONS FOR AGRICULTURAL EDUCATION BY A SOUTHERN STATE.

The state legislature of Arkansas has appropriated $350,000 for the erection of four agricultural schools and $500,000 additional has been raised by the cities. In the building and furnishing of the schools ideas suggested by the Stout Institute, of Menominee, will be largely used.

MEANINGLESS SCHOOL WORK NOT TO BE TOLERATED.

The day is fast passing when high school pupils will be required to do what to them is meaningless work simply because it is the custom. Neither will they be asked to do such work merely for some profound pedagogical principle which only the instructor may have in mind.—H. L. Terry, State Inspector of High Schools.

HISTORY OF COAL MINING.

Coal was first noted in the Coos Bay region about fifty years ago, Prof. J. S. Newberry having reported in 1855 that the coal deposits of Coos Bay had begun to attract attention. Some mining was done there in 1855 and 1872, and in 1876 two mines—the Eastport and the Newport—were in active operation. The Newport, however, was the only one to survive. The Beaver Hill mine was opened in 1895. This was at first an uncertain factor but is now one of the important producers.

COAL RESOURCES OF OREGON.

According to estimates prepared by M. R. Campbell of the United States Geological Survey, the total coal-bearing formations of Oregon are limited to an area of 230 square miles, the original contents of which are placed by Mr. Campbell at 1,000,000,000 short tons.

ENORMOUS PRODUCTION OF PETROLEUM.

The production of crude petroleum in California has increased from 33,098,598 barrels in 1906 to 39,748,375 barrels in 1907, to 44,861,742 barrels in 1908, and to 54,433,010 barrels in 1909. By far the larger part of this product is used as fuel and, estimating 3½ barrels of petroleum as equivalent in efficiency to a ton of coal, the total production of California petroleum in 1909 was equivalent to more than 15,500,000 tons of bituminous coal. California's petroleum production in 1909 was larger than the entire output of the United States in any year prior to 1896. Petroleum is a better steam-raising fuel than coal, requires no fireman, and produces no dust, cinders, or ashes, and it is not remarkable that coal mining in the state is at a disadvantage.

PHYSIOLOGY AND SEX HYGIENE FOR GIRLS IN THE TECHNICAL HIGH SCHOOL, CLEVELAND, OHIO.

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The growing interest in the teaching of sex hygiene is indicated by the increasing number of courses in this work offered in the schools throughout the country. Because of the comparative newness of the instruction it is well that a number of teachers describe their methods with a view to securing through a combination of the suggestions the best plan of handling the subject. For this reason a statement of the scheme for taking up sex hygiene with the girls in the Cleveland Technical High School is presented.

The work is a part of the freshman science for girls which consists of botany and physiology. Nominally they are separate but virtually the botany and physiology are closely related parts of the same course—a course in the study of life. Botany precedes human physiology, because a knowledge of the processes of life may be more easily approached through a study of plants. One of the difficulties of teaching a science in the freshman year is the lack of a scientific vocabulary. The pupil who has been studying botany comes to physiology with the necessary terms acquired, in part, and used in the two relationships they have a fullness of meaning not possible when learned only in connection with one subject. For example, after the study of cell breathing in plants the pupil easily gets the idea that respiration in the human organism is not simply "inhalation and exhalation" but is essentially the interchange of gases in every living cell in the body and that the lungs and circulatory system are necessary to breathing only because the body is such a complicated organism. As with the term "respiration" so it is with other terms as "digestion," "assimilation," "reproduction," and "living cell." They carry a more definite significance.

In a study of life a knowledge of the living cell is essential, and the best forms with which to teach its structure are the lowest. The pleurococcus is used to show that every living cell is filled with protoplasm organized into a nucleus and cytoplasm, Simple cell division also is taught with this plant. This simple cell division which consists of the division of the nucleus into two nuclei with the formation of a wall between to make two cells is the fundamental step after fertilization in all higher reproduction.

The subject of fertilization is introduced with the ulothrix. At times this plant can be found in its reproducing condition so that the swimming cells can be seen. The fact that two swimming cells of the same size fuse to make a cell strong enough to resist the colds of winter make consideration of the plant a good beginning for the study of fertilization. The knowledge of the sex organs is first approached with an examination of the vaucheria. This alga with its sex organs of one cell is an excellent type with which to begin the subject. Indeed, the only essential terms used in the discussion of reproduction of the highest organisms are used in the study of this filamentous form. The value of using these simple plants in teaching the life processes increases with the number of algae which the time permits to be studied.

Although the essential ideas of reproduction are introduced with the algae, time would be lost if the botany were not continued farther, for one of the strongest points in leading up to this subject with botany is the constant repetition of the fundamental facts of reproduction as the pupil passes from the algae to the highest forms. For the sake of those not familiar with the science of botany it may be stated that the evolution of plants from the algae is traced through the evolution of the sex organs. In passing from the lowest group to the highest the sex organs become more developed and sex itself clearly established.

In studying this development, much time cannot be spent on the second group containing the liverworts and mosses. In the next group above the mosses the life cycle of the fern is the most valuable to young pupils because the plant is so familiar. The sex organs of this group are well developed and a knowledge of them helps form a groundwork for the physiology to follow.

The group above ferns is well represented in the parks by the pines and ginkgo. The general interest in the pines as well as their economic importance makes them a necessary part of the botany course. The distinct sexual cones, the conspicuous method of pollination and fertilization, and the formation of the embryo nourished by the female gametophyte make the study of the pine valuable in leading up to the succeeding course in animal life.

While the highest group, the flowering plants do not take up all of an introductory course as they once did they are worthy of a large proportion of time. A knowledge of them is indis-

pensable in art. Their economic and æsthetic value makes an education incomplete without a considerable acquaintance with them and their highly developed reproductive organs place them naturally in a course preceding human physiology.

As the essential facts in reproduction are repeated in the tracing of the evolution of the sex organs the scientific terms necessary in the physiology become commonplaces. Nowhere is the law of increasing returns better demonstrated than in repetition with young students. A principle stated twice has three times the familiarity it would have if presented but once.

A number of months elapse after botany is dropped before the subject of reproduction is taken up in the physiology. This is desirable for in the meantime emphasis is laid on the vital processes of digestion, nutrition, and respiration and the subject of reproduction is not given an exaggerated prominence in the course. The special work in physiology is introduced with a short review of reproduction in the algae and flowering plants. The transition from the plant to the animal is made by discussing simple cell division in the amœba, which has already been considered in the study of the white corpuscle. As zoölogy is not part of the curriculum, time will only permit that a few animals be studied.

Fertilization in animals is approached with a brief study of reproduction in a fish. Some time is spent in the study of the chicken, as the chicken egg is the only ovum which can actually be examined. The girls learn about the formation and the function of the yolk and white and that the disc on the yolk of the egg is a chick about seventeen hours old whose growth is temporarily stopped. Eggs which have been in an incubator are examined. The chicks observed are from about twenty-four to seventy-two hours old and show the automatic beat of the heart and the vascular system which is taking in the nourishment from the yolk. A detailed microscopic study of the chick embryo does not belong to freshman work.

A comparison is made betwen the ovum of the chicken and the ovum of the dog, between the diagrams of the reproductive organs of the chicken and that of the dog, and hence the difference in the way in which the embryo of the chicken and the embryo of the dog are nourished. The school owns a papier mache female human figure which is dissectible. The organs of the pelvic cavity are compared with diagrams of the reproductive organs.

of these animals. The functions of each organ of the pelvis is carefully explained, including development and nutrition of the foetus in the uterus. After the physiology and anatomy of the pelvic organs are completed the hygiene of these same structures is given careful consideration.

A purely scientific atmosphere is kept in the class room and the girls recite with as little self-consciousness as a university woman in an embryology lecture room. A number of women visitors have been present from time to time during the recitations and the girls retained their poise as when alone. With a view to securing coöperation between the home and the school, the girls are given nine typewritten sheets containing the essential facts under consideration and are requested to have their mothers read these pages with them. In a large proportion of cases the request is complied with.

The conditions for introducing the work in this school are favorable, as the course of study for the girls is entirely different from that of the boys. Then, too, the school is new and when this combination of botany and physiology was put in the curriculum there was no traditional work in the course to displace.

RESEARCH IN THE PEDAGOGY OF BIOLOGY.

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In the report of the committee of the biology section on the scientific study of education as printed in the January issue of School Science and Mathematics it was stated that this committee intended publishing a bibliography of the subject. The first installment of titles appears in this issue. Attention of those interested is called to it. Additional titles will be added from time to time.

A form has been adopted which will lend itself readily to card catalog uses as the references can be clipped and pasted on standard size cards if desired. It is the intention to so place the bibliography in making up the paper that nothing of permanent value will be destroyed by clipping.

The present references are largely statistical but others of an experimental nature will follow. There is no attempt to arrange the titles in any particular order in this publication since each reader will doubtless arrange them on cards to suit his own system of cataloguing.

Since education deals with the growth and development of man—an animal—the methods of investigation used must of necessity be closely related to those which are familiar to biologists. This is peculiarly true of those investigations in which variation plays a part. Teachers of biology should therefore enter this new field with peculiar interest.

The assistance of everyone interested is invited in order that the bibliography may be comprehensive.

As another department of its work the committee is very anxious to get into communication with anyone who is engaged upon a problem or with those who desire to take up investigation of this sort. The committee is charged with the duty of coöperation, but can do so only as it learns what is being done or projected. Please write to the chairman or to any member of the committee if you know of anything which is of interest.

TWO EXPERIMENTS IN ZOOLOGY TEACHING.[1]

By Frederic C. Lucas,
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I. AN EXPERIMENT IN TEACHING ZOOLOGY TO SEGREGATED CLASSES.

Owing to the general policy of the Englewood High School, Chicago, it has been possible to have my boys and girls in separate classes for the past three years, with results that have been very satisfactory. During this time I have been gradually differentiating the two courses, until now the boys' course is quite different from that of the girls, which latter is more like the original course. This differentiation has been made because of and after a close study of the characteristics of both the boys and girls and is an attempt to adapt the courses to the needs of the pupils in each case. A few of these characteristics as I have observed them may be of interest. Among the boys we have found a greater previous zoölogical experience, a keener curiosity, a greater independence, a desire to tabulate results rather than write long descriptions, a tendency to work rapidly, and in general, a desire to *do things,* rather than write about them. The girls on the other hand have had less field experience, have much less zoölogical curiosity, are more easily handled "en masse," and follow general class directions, work more slowly but produce

[1]Read before Biology Section, C. A. S. and M. T., at Cleveland meeting.

neater work, often spending extra time on title pages, etc. In general girls are more faithful in the preparation of outside work, but boys seem to get more out of their laboratory work.

The most striking results have been the increase in the number of boys taking the subject and the better grades obtained by the boys, who seem to be willing to strive with each other where they would be unwilling to compete with the girls. The pupils themselves prefer the segregated classes. If I had more time I would like to give you some of their reasons. As a teacher of zoölogy I would be very sorry to go back to the old plan of mixed classes.

II. AN EXPERIMENT IN PRESENTATION OF SUBJECT MATTER IN ZOOLOGY.

For the past year and a half, instead of following the old "type plan," I have been trying what might be called the "topic plan," these topics being some of the general laws or principles to be learned from a study of the animal kingdom. I cannot take the time to elaborate the idea at this meeting, but will simply give one or two examples. For instance, we do not study *Protozoa;* we take up the topic: *"The cell and what it can do,"* illustrating it by means of such cells and Protozoa as may best bring out the idea. Again, we do not study *Mollusca;* we take up the topic, *"Adaptations for Protection,"* studying Mollusca for exoskeleton; insects, for protective coloration; other invertebrates for other methods of protection. And so with other topics. When the pupil finishes his course, he has a broader idea than that *"Zoölogy is the study of Animals"* (we might say *"of eight animals"*).

POWER SITES WITHDRAWN.

Four new power site withdrawals were made, covering 6,670 acres, and five restorations were recommended, covering 40,432 acres, which field examination or other information showed to be not available as power sites. Up to December 1, 1,418,047 acres had been withdrawn for power purposes.

COAL RESOURCES OF GEORGIA.

According to the estimates of M. R. Campbell, of the United States Geological Survey, the total original coal supply of Georgia was 933,000,000 short tons, from which there had been mined to the close of 1909, 8,599,714 short tons, representing (including loss in mining) an exhaustion of about 12,750,000 short tons. This would leave still in the ground a total of about 920,250,000 short tons, of which about 600,000,000 tons may probably be minable.

HIGH SCHOOL COURSES IN BOTANY.

By Willard N. Clute,
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Taking down from my shelves twenty-four representative botanical texts and dividing them into the three groups of college texts, high school texts and laboratory manuals, I have, it seems to me, a very instructive set of views as to what should constitute a year's course in botany. There are, as most teachers are aware, two methods much in vogue for teaching the subject. One, which may be termed the morphological method, begins with the simplest plants and carries the thread of relationship through the various great groups to the angiosperms after which there may or may not be further work in the structure of flowering plants, ecology, economic botany or classification. The second method, which for want of a thoroughly descriptive term may be named the structural method, deals with the structure of the flowering plants beginning with cells or seeds and continuing through roots, stems, leaves, flowers, and fruits with more or less physiology and ecology woven into the study of each topic. Following this, may come more ecology, morphology, or systematic botany or occasionally a course composed of all three. The way in which the books mentioned divide between these courses is most interesting.

Practically all the college texts are committed to the morphological method of approach. A few begin with some pages devoted to physiology but all soon plunge into a consideration of the spore-plants and end with more or less ecology. We, therefore, seemed justified in concluding that this method is regarded as the standard one for the colleges.

The attitude of the texts designed for use in the high school is radically different, even when they are written by authors who have written college texts. For the first half-year practically all agree in placing the emphasis upon the study and function of the higher plants, taking up the various structures in about the sequence in which they appear in nature. A very few defer the study of the physiology and ecology of such structures until the end of the course, but the majority use these subjects to interpret the structures as studied. One discerns in this method certain features of the once-prevalent course in preparation for the "analysis" of flowers, but there is now a commendable absence of

the terminology formerly so conspicuous, its place being taken by experiments in physiology, more extended studies in structure and the like.

The laboratory manuals are about equally divided between the high school method of attack and that of the college. Of the nine works examined five place studies of structure first and four incline to morphology. It is a significant fact, however, and one that strongly emphasizes the differences between high school and college botany, that the texts that favor the structural method are either written by high school teachers or those chiefly concerned with good teaching in such institutions while the others have been made by college men who naturally follow the methods by which they have been taught.

The numerous difficulties in the way of beginning botany with young people by the spore-plant method inclines the high school teacher to avoid it and the position of the books as to the content of the first half-year of botany seems eminently sane and sensible. It is quite likely that so long as botany forms part of the school course the structure of flowering plants will be considered the easiest method of approach. Such a course also has the merit of being an excellent foundation for any further botanical work.

Though the authors of our texts are agreed upon the content of the course for the first half-year, no such unanimity of opinion prevails regarding the rest of the course. A large number still lean toward flower analysis or at least to plant-naming and herbarium-making; other offer instead a study of types from algae to flowering plants, while still others favor agriculture, ecology, economic botany, or a survey of the principal plant families. That a good botanical course can be built up with any of these as a basis no one will deny, and some may insist that this diversity in the second half-year is desirable, but granting that all are equally valuable, educationally, it seems possible that we might select the course that is also most useful and therefore arrive somewhat nearer uniformity in the matter of presenting the botany of the second half-year.

No one will question the value of a good course in systematic botany, but there is much to be said against the course as it is frequently given. Herbarium-making and the analysis of flowers is not worth the time it takes though this still forms the main part of the course in some quarters. The manuals used with such a course seldom contain any but the more showy wildflowers

whose common names are, in a majority of cases known to the pupils, In consequence, the index, rather than the key, is depended upon for the names. The keys, also are seldom strictly scientific and the descriptions are rather more "popular" than is consistent with accurate work. If systematic botany is to be regarded as merely a means of learning the names of the flowers, it would be far better for the pupils to go afield with the teacher and be told the names outright. With a complete manual, however, the case is very different. Then the pupil learns how to use a real key, the many additional species listed requires him to be exact in his identifications while the fact that all the species of his region may be found in the book allows him to work with any flower with the certainty that careful work will run it down. Nor should the pupil be kept on the work of identifying the flora so steadily that he has not time to get a broad survey of the whole field of classification. Recognition of the large plant families is just as important as the recognition of the species common to the region. It is by such courses as this that the good systematic botanists are made.

Although the course in morphology is so extensively given at present, there seems to be pretty good grounds for thinking that the majority of pupils get very little out of it. It is easy to teach them the characteristics of typical plants in each phylum but the knowledge is of little use to them unless applied to an interpretation of plant evolution, a subject for which most first and second year pupils are not ready, principally because they have not yet a sufficient background of facts for its proper apprehension. If this part of the study is deferred until the pupil has had one semester's work in systematic botany, the pupil then has a working knowledge of the relationships and meanings of orders, families, genera and species to serve as a basis of such evolutionary studies.

Viewed from the standpoint of the child, however, neither morphology nor systematic botany is as attractive as that phase of botany called agronomy or agriculture, which is beginning to make its appearance in some schools and seems destined to have a much greater vogue. No course is more useful or for that matter more instructive. The average child does not take botany with the expectation of becoming a botanist. He is more or less attracted toward plants and wants to be taught more about them. The study of structure, physiology, and ecology are right in his

line, but his interest seldom extends to the flowerless plants. In time he is likely to settle down in a home of his own and then he is interested in how to make a lawn, what kind of shrubbery to plant, how to trim his trees, how to cultivate his garden crops, how to circumvent his insect and plant foes, how to protect his plants from frost, how to improve both vegetable and flower garden, how to multiply choice specimens and a hundred other questions which his botany in school will not enable him to answer. A course in agronomy would make him a more useful as well as a more intelligent citizen. Moreover, the practical work connected with such a course, forms a safe outlet for much of the spirit that otherwise results in mischief. Why we should insist upon his taking morphology instead of the more useful study is beyond comprehension unless it is because we have gotten into a rut. If we can give but a year to botany in the high school it would seem best to make this a study of structural botany and agronomy, leaving to the college the treatment of the spore-plants. But even this is not necessary. So long as Latin, German, French, and other studies have more than a year devoted to them there seems to be no valid reason why botany should not be as well treated. In this case, morphology and systematic botany need not be deferred until college is reached but may be given in school to those whose other botanical work has shown them to have an aptitude for such things.

PHYSICAL GEOGRAPHY VERSUS BIOLOGY IN THE FIRST YEAR OF THE HIGH SCHOOL.[1]

By Stella S. Wilson,
School of Commerce, Columbus, O.

(Abstract.)

The question is: which science is the most helpful to all first year students?

Biology requires expensive equipment, small classes or sections, longer laboratory hours, a larger teaching force, and the use of many technical words.

In biology specimens can be placed in the hands of the pupil and there is a splendid chance for the development of observational power, but here arises the question of material for large classes.

[1]Read before the Earth Science Section, C. A. S. and M. T., Cleveland, 1910, meeting.

The course in geography at the School of Commerce, Columbus, begins with a short course in the elements of physics and chemistry—very helpful in the year's work in geography. The main topics included are: matter—its states and properties; gravity; inertia; diffusion; molecules and atoms; water—its forms, properties, freezing effects, uses, and methods of purification; convection; et cetera. This portion of the work is largely experimental and notes are kept for reference.

The text-book is now taken up in the light of the previous work and certain topics, for example, eclipses, magnetism, et cetera, are illustrated by additional experiments.

A month is spent on the atmosphere with accompanying study of weather conditions and weather maps. The oceans are illustrated by lantern slides of shore lines, harbors, et cetera. The tides are further illustrated by apparatus.

About two weeks are spent on rocks, minerals, and ores. This proves very helpful in later studies, such as mountains and erosion.

In the study of land forms, for example, mountains, location and naming exercises are introduced to give the regional idea. Also the effects of topography on industry are noted.

Four weeks or more are devoted to the geography of Ohio, its rocks, rock structures, land forms, river basins, divides, glaciation, cities, and industries.

The reasons for placing such a study in the first year are these:

(1) To reach as many future readers, travelers, and citizens as possible.

(2) Large classes can be handled without expensive individual apparatus.

(3) The work is varied and general and requires few technical terms.

(4) It teaches the proper relations of the atmosphere, water, and soil to each other and thus lays the foundation for biology, and the other sciences, and for history as well.

DEEP MINE SHAFT.

The deepest vertical shaft in the world is the No. 3 shaft of the Tamarack, near Houghton, Mich. It lacks 27 feet of being one mile deep. Another shaft at the Tamarack and the Red Jacket of the Calumet & Hecla are, respectively, 5,089 and 4,920 feet down. The deepest gold mine shaft in America is that of the Kennedy at Jackson, Cal., this being 3,450 feet deep.

INDUSTRIAL GEOGRAPHY: ITS MEANING, SCOPE, AND CONTENT.[1]

By Carl F. Knirk,
Technical High School, Cleveland, O.

Among the factors which help to shape the content of a course in geography are the demands placed upon a school by its patrons and the needs of the pupil. The geography teacher must decide whether it is of more value for a boy to know the various theories of glacial movement or to know that the Great Central Plain region north of the Ohio and the Missouri Rivers has a deeper mantle rock and a more fertile soil because of the former presence of glaciers and consequently that this plain has the most valuable agricultural land in the world. Again the teacher must decide whether a discussion of why our forests should be preserved in certain areas involves as much scientific thinking and supplies as valuable knowledge to the average boy as a discussion on the volume, velocity, and carrying power of a stream.

Industrial geography begins with a study of the atmosphere, weather, and climate. It places emphasis on the human responses to atmospheric conditions, and gives the boy an opportunity to observe and interpret some of his surroundings.

The weather and climate are followed by a study of the processes which commonly modify the surface of the earth together with the surface features which are thus produced. The interest in this work is intensified and the work is made vital by showing how most industries are largely determined by their physical surroundings. Thus, mature regions, with their deep valleys, are usually mining areas because, (1) the rocks of various strata are exposed, making it easy to find the minerals, and (2) strata which have long been buried and which are, therefore, likely to contain mineral deposits are brought near the surface.

The knowledge thus gained prepares the students for a study of regional geography which is both systematic and causal. This regional geography will acquaint the student with the larger physical features of our country and those of the leading nations in western Europe, it will give him an idea of the resources of this country, it will teach him something of the value, distribution, and relation of the various industries and most of all it will show him that the life of a nation is dependent on the nation's re-

[1]Summary of paper read before the Earth Science Section, C. A. S. and M. T., Cleveland, 1910, meeting.

sources and hence on those industries which employ the great mass of the people.

In conclusion, industrial geography aims to teach those phases of weather, climate, and physiography which are deemed essential to a rational geography understanding of regional geography. It presents regional from a physiographic standpoint and it places emphasis on the causal relations which exist between the physiographic and climatic conditions and industries. It aims to present locational geography through a thorough map study in connection with regional geography, and lastly, it familiarizes the student with the conditions under which he and his fellow men live, and the needs and demands of the leading nations with which our country deals.

COAL MINING IN IDAHO IN 1909.

Several rather small and widely separated areas in Idaho contain subbituminous coal or lignite, from which small quantities are mined annually for local consumption. The production in 1909 amounted to 4,553 short tons, valued at $19,459, a decrease, as compared with 1908, of 876 tons in quantity and of $2,373 in value. The output in 1909 was obtained entirely from Fremont and Lemhi counties. A small production was reported in Bingham County in 1908, but none in 1909.

COAL IN THE GROUND IN MONTANA.

According to the estimates of M. R. Campbell, of the United States Geological Survey, the original coal supply of Montana was 303,000,000,000 short tons, from which there had been mined to the close of 1909 approximately 29,300,000 tons representing an exhaustion, including the waste in mining, of about 44,000,000 tons, or 0.015 per cent of the original supply.

QUANTITY OF COAL MINABLE IN NEW MEXICO.

According to the estimate of M. R. Campbell, of the United States Geological Survey, the original coal supply of New Mexico was 163,780,000,000 tons, so that the exhaustion to the end of 1909 represents approximately 0.02 per cent of the original supply.

SOME HISTORY OF MARYLAND COAL MARKETING.

Coal was discovered in the Georges Creek basin as early as 1782, but the first eastern shipments of Maryland coal were made in 1830, when small amounts were sent by barges down the Potomac. Shipment by barges was so destructive of life and involved so much loss of coal that it was soon abandoned, and it was not until the Baltimore and Ohio Railroad was built, in 1842, that the industry began to become important. The first shipments over the Chesapeake and Ohio Canal from Cumberland were made in 1850

GENERAL SCIENCE VERSUS PHYSICAL GEOGRAPHY.

By Percy E. Rowell,
Gardena Agricultural High School, Gardena, Cal.

There appeared in the December number of School Science and Mathematics an article attacking general science as a first year science, which, on account of its fallacious arguments, and because it showed an apparent lack of knowledge concerning general science, requires a reply, not so much as a defense for general science, which needs no defense, but more in justice to this introductory, beneficial, but maligned course.

To quote from the article in question: "Now let us see what are some of the causes which have led to an attempt to substitute general science for the broad earth science of physical geography. Among these causes we might mention: (1) The complete ignorance of the meaning of the simplest physical phenomena on the part of pupils entering the high school. (2) A growing feeling on the part of many science teachers that in order to maintain the technical standard of their work, and satisfy university requirements, that an introductory science course is needed; and (3) A conviction on the part of many, due to a lack of knowledge of the possibilities of the subject, that physical geography, or physiography, cannot offer the preliminary training."

Cause (3) is the nearest correct although it should read, "A conviction on the part of many that physical geography cannot serve the purpose for which general science is intended." This is due to their knowledge of the limited possibilities of physical geography *if it is to remain physical geography*. Up to the time of reading this article I was under the impression that physics was the fundamental science of sciences, and that all other sciences, including a study of natural land forms, were merely branches into which physics had been divided for ease of study. General science, then, to be general, must be based upon the phenomena of this large conception of physics. Does this include physical geography? Yes, but it is not limited by one little branch of science: it includes all science. It is not nature study, either of the right sort or of the wrong sort: it is life.

Cause (1) is not given by the advocates of general science. While we all acknowledge and deplore the truth of this statement, the purpose of general science is not to supply the lack of science training in the grades any more than is the course of

algebra planned, or introduced, to correct a deficiency in mathematical development in the lower schools. General science was introduced, is being introduced, and will continue to be introduced, until it becomes the universal first year science, for the dual purpose of giving information and stimulating ambition, scientific or technical.

Cause (2) does not seem to be a valid reason for the introduction of general science. Why prepare seventy-five per cent of the pupils for courses which they will not take even in the high school? Only about twenty-five per cent of those who enter from the grades take chemistry, and about five per cent take physics, although nearly ten per cent enter college. No, the purpose of general science, and the one cause which will make the course a success, is to give all of those who enter high school a little scientific knowledge which they would not otherwise obtain. Since the time is limited, in which the pupil may receive this scientific instruction, no one science can possibly meet the requirements. We must have general science.

We may make lengthy statements in regard to what should be done to the child before he goes to high school. We may try to force more and more subjects into the grades, and, the pity is, we succeed too often! Pupils enter the high school with a whole lot of flashy acquirements, mere surface polish, bubbling with words, but without sense. Too often the grades produce parrots and not intelligent children, ready for higher instruction, and the high school is to blame because it has required subjects to be taught in the grades which take the pupils' time away from subjects which are more essential. The high school is more to blame because it has not the moral courage to say to the pupil, "The instruction in this school is by subjects and not by years. When you have learned enough to merit a diploma it will be given you. This may take four years or it may require six years." The high school tries to throw its responsibility upon the universities, because the latter are requiring more work. But the universities have only stated the least amount of studies upon the satisfactory completion of which they will admit students. They do not say that the work shall be completed in four years and they admit students of all ages. The high school might learn from the universities and require something more than a grammar school diploma from its entering classes. Education in the grades should be by subjects and not by years. There is too much shirking of responsibility; too much "passing on."

To quote, "As conditions are at present perhaps one third of eighth grade pupils never enter the high school, but go out into the active duties of life completely ignorant of the simplest physical, chemical, and biological facts illustrated in the phenomena of everyday experience." This is probably true in many places, but what is far worse is the fact that nearly all of the grammar school graduates go out of the eighth grade not properly prepared in the elements of arithmetic, reading, spelling, writing, and behavior. The chief reason for this state of affairs is because the high school has insisted that so many additional studies be put into the curriculum of the grades that the pupils are poorly grounded in all. This, combined with the sentimental and fatuous idea that grammar school children should not study at home, has produced, and will produce, intellectual weaklings. However, while these conditions exist, the high school must take these children as they are and change them as they can. General science cannot fail to do this, if it is really general, for then the subject is lived.

My conception of what should constitute a grammar school course belongs in another article, but I do not wish to give the impression that I consider nature study and manual training, with akin subjects, out of place in the grades. I strongly believe in them. I do feel, however, that the business of the grammar school, first and foremost, and all the time, is to teach ordinary, simple arithmetic, spelling, writing, reading aloud, and some history and geography. If that can be accomplished, and at the same time have other subjects taught, and this combination is being accomplished in some schools, then the other subjects are not out of place. If the elements of the old-fashioned grammar school education cannot be given, because of the time devoted to the extra studies, then those extra studies are out of place. The idea that a man or woman can be fitted for life between the ages of six and fourteen is preposterous. Much which passes for education, or knowledge, and seems to indicate reasoning power on the part of the grammar school pupil is only mimicry. The child is a hypocrite and the educational system is to blame. The high school must not shirk its responsibilities which include the teaching of an introductory, general science.

The great object of general science is to humanize science and make it really appeal to the mind and imagination of the young pupil. Physical geography may do much along this line although most will be accomplished by making use of those parts of gen-

eral science which physical geography has appropriated, for its own, from the great science—physics.

Physical geography means natural land writing, or drawing, or the changes which have taken place upon the land through the natural agencies, unaffected by the actual work of man. Since water affects the surface of the land, it may be studied in physical geography, but merely as an agent of erosion. The matter of storms should come under meteorology; the study of the composition of water under chemistry; the characteristics of water under physics; and the consideration of the vegetable and animal life, in the water, under biology. This is one example, but many more similar ones might be given. If physical geography is to supply instruction in all of these details, it should be honest and change its name to general science!

On the other hand there are countless matters of everyday experience which vitally affect the individual and which must interest him, none of which can by any stretch of an elastic and all embracing imagination be made a part of a course in physical geography. Here are a few: Baking powder, baking, combustion, digestion of food, soap, electrical apparatus, sound, light, color, reading meters, the rotary lawn sprinkler, growth of plants, decay, disease, bacteria, house design, business theory. . . . This is only a short list which might be almost indefinitely lengthened. These facts may not seem to be related. Shall that be the reason why they shall not be taught during the first year of high school, or shall the reason be because they cannot come into a physical geography course, which is already stretched to the breaking point? These facts are just as much related to one another as one day of a man's life is related to the next day. Different viewpoints arise and old viewpoints change, but it is all one life. Too far already have we gone into scientific classifications and beautiful coördinations. We now have physics in the high school with practically no pupils. Chemistry is approaching the same condition, and judging from the vigorous, although futile, defense of physical geography, it also, a beautifully "harmonizing and unifying" science, is feeling the first approach of dissolution.

The strongest argument which has been made against general science, is that properly prepared teachers cannot be found; yet in the defense of physical geography the same excuse, for its failures in the past, was given—teachers not well prepared. It would seem, then, that this argument may be disregarded, since

the matter lies between physical geography and general science. It is not probable that there are teachers who are any better prepared to teach physical geography, which is advocated to unify everything, than to teach simple general science. The real physical geography requires special training which must be acquired under competent instructors.

The first laboratory manual which is mentioned in the article is not called a manual for general science. Its name is "Laboratory Manual of First Year Science." There is no text, therefore, no "unifying principle." Teachers must be credited with being able to supply some instruction, and this book was offered to furnish details of experiments which had been tried and had been found to be satisfactory for the purpose. If the general science teacher will plan out, at the beginning of the year, the subject matter to be covered in a general science course, and make a rough outline, this can be filled in and enlarged, as the year progresses. Then if each time anything of interest arises, notes can be made in this rough outline, and within a year the teacher will have become a good general science instructor. The same is not possible in the teaching of real physical geography, which actually is a highly specialized science. If it is expected to produce teachers who are fully informed in all of the sciences in order that they may be prepared to teach general science, then the impossible has been attempted. General science does not require this preparation. It does require teachers who are broad minded and who take a delight in the stimulating of scientific imagination and ambition; who consider an aroused intellect better than an orderly presentation of a unified science. A definite end but a grander end than the completion of a branch of high school science.

"Science is cold, abstract, impersonal. Geography is the same thing vitalized." Yes! Vitalized by what it has appropriated from physics. General science has the same parent source. Can it not be as "vitalized with flesh and life," when it admits its origin, as is possible with the science monopoly—physical geography? It would be hard indeed to find a teacher of general science who is not "giving a course essentially physical geography"!

Relegate to physical geography only its own phenomena and it is an addition to any high school curriculum. Divest it of all of the general science which it has and it would become a good second year course, of one term only. The second term should

be meteorology. Those students who did not care for the natural sciences could take general biology in the second year. The rest of the school curriculum might be left as it is, as far as the sciences are concerned. Even under these conditions physical geography need not become formal.

General science is an introductory science, not as a preparation for biology, chemistry, or physics, but it is a course in which the pupil and science make their first bow. Its purpose is to awaken the pupil to a fuller realization of his surroundings, to fire his imagination, and to shake off apathy and superstition. The course should make him cease merely to absorb facts and formulas, and get him into the condition in which he is ready and willing to be educated.

COLLEGE ENTRANCE EXAMINATION BOARD.

The annual meeting of the College Entrance Examination Board was held at Columbia University on November 12. Tufts was admitted to membership, bringing up to thirty the total number of colleges represented. A standing committee of seven was named to study the reading and rating of examination books and the standards of marking. The list of examiners appointed to prepare examination questions in the sciences for 1911 is as follows:

Botany—Chief examiner, Willard Winfield Rowlee, Cornell; associates, Mary Elizabeth Kennedy, Mount Holyoke; Louis Murbach, Central High School, Detroit, Mich.

Chemistry—Chief examiner, Alexander Smith, University of Chicago; associates, Gregory Paul Baxter, Harvard; Boynton Wells McFarland, New Haven High School, New Haven, Conn.

Mathematics—Chief examiner, Robert Woodworth Prentiss, Rutgers; associates, Herbert Edwin Hawkes, Columbia; Edward B. Parsons, Boys' High School, Brooklyn.

Physics—Chief examiner, Frank Allan Waterman, Smith; associates, William Edward McElfresh, Williams; Daniel Edward Owen, William Penn Charter School, Philadelphia, Pa.

Zöology—Chief examiner, George Howard Parker, Harvard University; associates, Charles Wright Dodge, University of Rochester; Walter Hollis Eddy, High School of Commerce, New York.

ELEVATION BENCH MARKS.

Since 1897, when the United States Geological Survey was authorized by Congress to determine elevations above sea level at various points and to set bench marks to preserve the data, the Survey has done more than 200,000 miles of spirit leveling and set more than 24,000 of these marks. One type of metal mark is a tablet 3¾ in. in diameter, with a stem 3 in. long. The castings have been made of brass, and aluminum bronze and are placed on masonry structures, large boulders, solid rock, etc. The stems are inserted in drill holes and fastened with cement.

HOW I ATTEMPT TO TEACH THE MEANING OF A CHEMICAL FORMULA TO HIGH SCHOOL JUNIORS.[1]

By Frank B. Wade,
Shortridge High School, Indianapolis, Ind.

Most of us have noticed the ease with which high school pupils acquire the art of balancing chemical equations and many of us have found to our shame how little those same pupils realize of the true meaning and content of the equations which they so skillfully balance.

With a view to giving the pupil a larger understanding of chemical formulæ and equations, even at the expense of decreased skill in the delightful game of balancing the expressions for complicated reactions, I have, for some years, devoted a large part of the first half-year to an extended study of water with a view to gradually working out its formula from an actual acquaintance with the substance itself.

At the outset the pupil is in very much the position of the ancients for, as far as he knows, water is an element. The first attack upon the water is made with metallic sodium. A little time is given to getting acquainted with the properties of this substance on the ground that one should be informed in regard to the nature of the tools one uses. Then small pieces of sodium are allowed to act upon a limited amount of water in a 3 inch evaporating dish. The resulting phenomena are observed and some of the gas which escapes is ignited and found to burn freely. By wrapping a bit of sodium in a piece of filter paper and swiftly placing it beneath a wide test tube filled with water and inverted over a pneumatic trough of water some of the gas may be caught and its properties studied. The paper containing the sodium is, of course, held by means of tongs. The information that this gas is called hydrogen is then given and some little time is next spent in preparing more of it by the various laboratory methods, using several of the more active metals with water and other less active ones with each of a considerable number of acids. Hot water or steam may be used with magnesium or zinc, or steam with iron, to illustrate differences in the activity of the metals under varying temperatures. At this stage of our investigation of water the pupil has learned that it is not an element since it may be decomposed and he can safely write H_x Y_y as a tentative formula

[1]Read before the Chemistry Section, C. A. S. and M. T., Cleveland, Ohio, Nov. 25, 1901.

for water, the H_x standing for an unknown amount of hydrogen and the Y_y for an unknown amount of some other substances or substances.

The residue from the action of the sodium upon water is next evaporated to dryness. The elementary nature of sodium is announced as a fact found out by others. Zinc, with which the pupils are already familiar from having used it in connection with their previous study of air, is next used, in the form of zinc dust, which is mixed with the powdered residue and heated strongly in a dry test tube. Hydrogen is of course again released and the pupil is led to argue that, since zinc like sodium is an element, the hydrogen must have come from the original water. Hence, water contains some hydrogen which sodium drives out in the cold and some other hydrogen which is driven out by heated zinc. As no quantitative determination of the hydrogen is made in the two cases, about all the pupil can add to his formula is a sub-number showing that the hydrogen is in two portions of unknown size thus—H_{x+z}— the whole formula being at this stage $H_{x+z}\,Y_y$.

Our next attack upon the water is to subject it to electrolysis. The Hoffman electrolysis apparatus is made use of and the experiment is made a lecture-table experiment. All of the preceding work may safely be done by the pupils themselves and if time and equipment allow, the electrolysis of water may also be performed by the pupils. Distilled water is first employed and the failure of the current to pass is noted by the pupils. Some dilute sulphuric acid is then added to the contents of the apparatus and the pupils are informed that careful weighing has demonstrated that none of the acid so added is permanently changed but that all of it may be recovered at the end of the experiment. Any gaseous products obtained must, therefore, come from the water. Upon collecting sufficient volumes of the two gases the current is stopped and the volumes of the gases read, with due regard to the effect of the water column. The gases are then tested and found to be hydrogen and oxygen. The latter element is already familiar to the pupils from their study of air.

At this point Avogadro's hypothesis is introduced and its probable truth defended from the known behavior of gases, particularly under changing temperature and pressure, with which behavior the pupils are already acquainted.

The inference is then drawn that the number of particles of hydrogen in water is double the number of oxygen particles if Avogadro's hypothesis is correct. The formula then becomes

$H_{2x}O_x$ the information being furnished that no one has ever found any elements other than hydrogen and oxygen in water.

A gravimetric analysis of water is next in order as a means of introducing the matter of combining weights and atomic weights, the latter being introduced as least combining weights. This gravimetric analysis I formerly actually attempted before the pupils, using the method of reducing a weighed (by means of hot H_2) quantity of cupric oxide, self-prepared before the pupils from a weighed quantity of copper, and catching and weighing the water formed, thus determining the hydrogen by difference. I found, however, that in order to get results that would even roughly approach the true weight relation between the hydrogen and the oxygen of water such great care was required as to make the experiment undesirable as a lecture experiment. I have since gone through the motions without actually weighing the several substances and have thus given the pupils an understanding of one of the ways in which the respective weights may be determined without actually making the quantitative determination. The results of Morley's work are then given to the class and used by them to calculate the combining weight of oxygen in water. The 8 to 1 weight relation and the 1 to 2 particle relation are then worked out giving the 16 to 1 relation between single particles of oxygen and hydrogen. With the knowledge that each oxygen particle is 16 times as heavy as each hydrogen particle the results of the volumetric synthesis of water are next reported to the class. They already know the 2 to 1 volume relation of the hydrogen and oxygen but the fact that two volumes of steam are formed is new to them. By means of Avogadro's hypothesis it is now reasoned that each hydrogen gas particle must contain at least two atoms. The vapor density of steam is next reported to the class and the molecular weight reasoned out. With 18 times the least hydrogen weight as the maximum value for the molecular weight of water our old formula $H_{2x}O_x$ can only become H_2O.

All this takes time but it is worth it. You can be sure that the pupil will know something at least about how the formula of at least one substance is obtained and what it means.

I usually have my classes work out the formulas of HCl and NH_3 after they have finished the formula of water, but make the experimental part briefer and borrow more results to reason from. I then tell them that we have no more time to devote to determining formulæ for ourselves and that in the future they

must take the results of others' work, which they can safely do in full confidence that the methods by which the results were obtained were as logical as ours, and the experimental work far more accurate than any that we did in determining the formula of water.

SOME NEW MODIFICATIONS OF OLD EXPERIMENTS IN PHYSICS.

By E. S. Bishop,
The School of Education, The University of Chicago.

I. HOW TO OBTAIN THE BEST RESULTS FROM A TUNING FORK WHICH VIBRATES SYMPATHETICALLY WITH ANOTHER.

The tuning forks are first brought into unison by sliding a piece of soft rubber tubing, about half an inch long, up or down one prong of one of the forks. The open ends of the resonators are then placed a short distance apart and each resonator is placed upon two pieces of new soft rubber tubing. If the experiment is tried first without the soft rubber tubing supports and then with them the intensity of the effect is easily seen to be several times as great in the latter case. By this method the author made audible over a large room a tuning fork of the cheapest grade used in the laboratory. For those whose hearing is somewhat impaired, vibrations of the second fork may be made visible by suspending an elastic ball about a quarter of an inch in diameter with a thread four or five inches long so that it just touches the prong of the second fork. The fork in this case made the pendulum in contact with it vibrate through an amplitude of a least half an inch, which could be easily seen in all parts of the room. The function of the soft rubber tubing is to conserve the energy of the forks in themselves, thus preventing the dissipation of energy to the table which results when they rest directly upon the table.

II. A DEMONSTRATION EXPERIMENT ON ABSORPTION.

Using sunlight or parallel rays from a projection lantern and a single slit of the optical disc, first place a piece of heavy plate-glass, silvered on the back, in the path of the rays and obtain the multiple reflections of the beam upon the disc, as in Fig. 1. Then replace the piece of silvered plate-glass with one which has been

covered on the back with a mixture of lampblack and banana oil. In the second case the only reflection obtained is at the first sur-

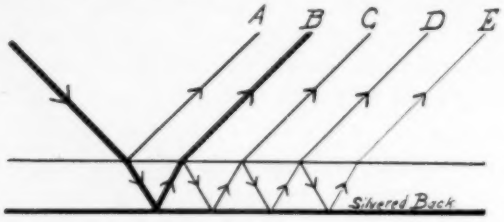


Fig 1

face, the beam which passes into the glass being so completely absorbed when it reaches the blackened surface that multiple reflection does not take place (see Fig. 2).

The experiment also shows that when reflection takes place from a mirror most of the light is reflected by the silvered surface, for the beam B from the back of the mirror is much more intense that the beam A or any of the multiple reflections following B.

III. A CONVENIENT METHOD OF PROJECTION.

Place the electroscope or whatever is to be projected upon the screen immediately in front of the objective of the projection

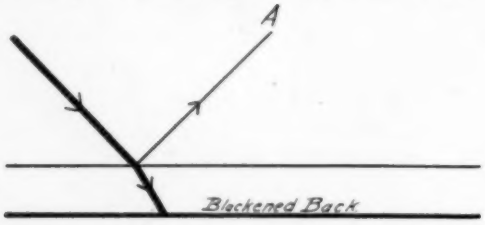


Fig 2

lantern, thus using the whole lantern as a condenser. Then place a convex lens in front of the object and move it toward the screen until the object is distinctly focused on the screen, the object and screen then being at conjugate foci. The proper focal length of the lens will depend on the magnification desired and the distance to the screen. For most purposes a lens of focal length between twenty and thirty centimeters will be found suitable.

A glass tank of any dimensions may be placed in front of the lantern and used to contain the elements of a voltaic cell, and when the electrodes are focused on the screen it makes a very convenient method of showing such phenomena as effect of

amalgamating zinc plates, formation of hydrogen at the positive electrode, etc.

The method is convenient for projecting many other experiments upon the screen.

IV. A MODIFICATION OF AN EXPERIMENT ON AIR PRESSURE.

Take two glass constant-weight hydrometer tubes, fifty or sixty centimeters long, such as are used in Millikan and Gale's laboratory course, the two tubes being of the proper diameter so that one slides easily into the other. Fill the larger one with water, push the smaller one part way down into it, invert both, and the pressure of the air will force the smaller tube completely into the larger one when the whole is supported by holding the larger one in the hand or a clamp.

If the tubes fit very closely the action will take place more rapidly when gasoline is used in place of water, as the gasoline runs out between the tubes more easily.

V. A MODIFICATION OF THE CARTESIAN DIVER, OR A FAKE LUNG TESTER.

Invert a small pill bottle partly filled with air (but not sufficiently to float) in a flat bottle filled with water. With the aid of a finely drawn-out tube with a J on the lower end and a rubber from a pen filler on the top, force fine bubbles of air into the pill bottle until it just rises to the surface. It will then be very delicately balanced so that a small increase in pressure will cause the diver to descend. Then cork the bottle with a rubber stopper, into which is inserted part way a glass tube. Attach a piece of rubber tubing to the glass tube to blow upon. The pressure which causes the diver to descend is obtained by pressing upon the sides of the bottle. This can be done unobserved by the person blowing on the tube while it is held in the hands. The apparatus is then given to a friend or member of the class who attempts to blow the diver down but, of course, fails.

If a slight pressure on the sides of the bottle fails to cause the diver to descend, force the stopper into the bottle a little with a rotary motion until the diver just starts down, and then the added pressure necessary to send it down may easily be obtained by pressing the sides of the bottle between the thumb and finger.

An outfit looking exactly like the one just described may be made to accompany it, the only difference being that the glass tube runs completely through the stopper instead of part way.

This diver can then be forced down by blowing on the tube but not by pressing on the bottle, the reverse of the other one.

The diver in the first outfit may be so delicately balanced that when forced down by pressure from the sides of the bottle it will stay at the bottom due to the pressure of the liquid above. It may then be caused to ascend by pressing lightly on the edges of the bottle, thus relieving some of the pressure due to its being corked tightly. It is very interesting to see how even a heavy flat bottle will thus have its volume diminished by a slight pressure on the flat sides and increased by a slight pressure on the edges.

VI. A LABORATORY METHOD FOR DETERMINING THE INDEX OF REFRACTION.

Take a rectangular battery jar about twenty or twenty-five centimeters deep. Fasten a piece of fine white thermometer tubing, T, across the middle of the bottom, and paste a paper scale on the outside of the jar so that its zero end is even with the upper edge of the thermometer tubing (see Fig. 3). With the aid of another piece of the same kind of tubing held just outside the jar, locate by the method of parallax the image, T', of the tube in the bottom of the jar. The reading at the top of the tube outside subtracted from the depth of the water will then give the distance of the image below the surface. Call this distance i. Call the distance from the top of the tubing in the jar to the surface of water o. This is read off directly on the scale. Then the index of refraction $n=o/i$.

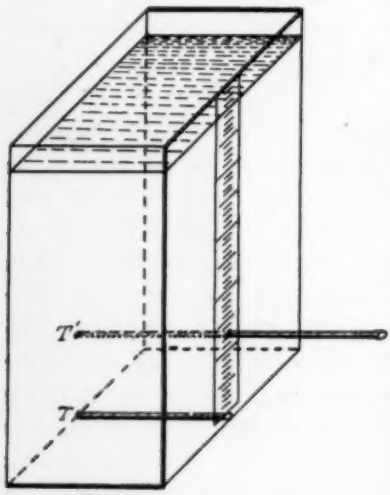


Fig 3.

The following values for the index of refraction of water were obtained from ten successive independent observations: 1.351; 1.338; 1.333; 1.338; 1.327; 1.346; 1.332; 1.339; 1.341; 1.323. Mean value of $n = 1.337$.

This experiment was suggested from the theory underlying it as found in Millikan and Gale's *First Course in Physics*, page 411.

A CHEAPLY DEVISED ATWOOD'S MACHINE.

By C. L. Vestal,
High School, Keokuk, Ia.

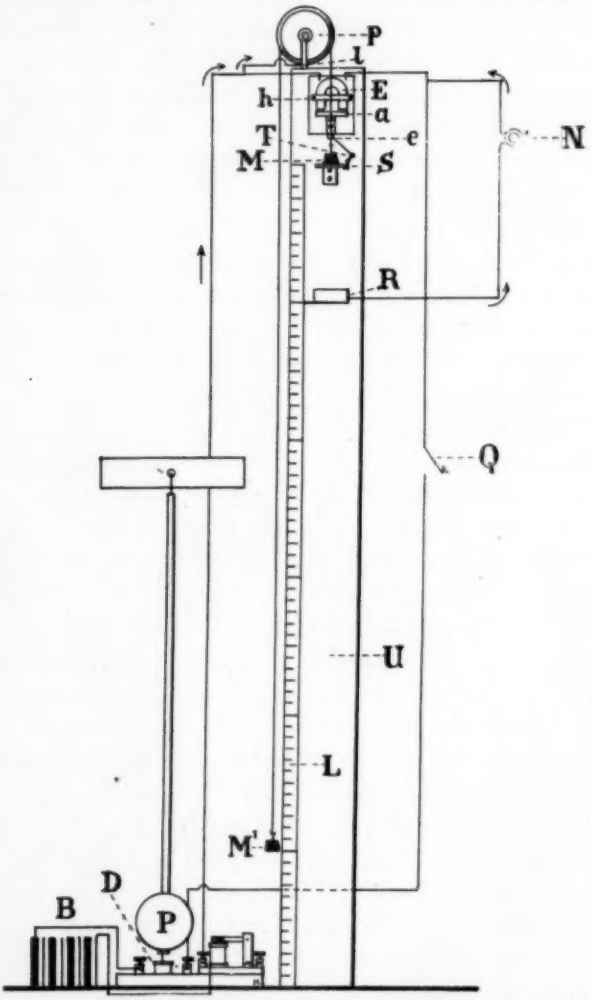
There are still many high schools whose principals will sing loud the praises of the "science" teacher who can make his own apparatus. Thus they justify to themselves a policy of penuriousness in the matter of material equipment. As a general principle it may be asserted that the physics teacher should not be required to "cobble up" apparatus which can just as well be purchased already made. He is usually a busy man. But it often happens, even in a good school, of middle size, there are certain large pieces of apparatus which may be called fundamental in an equipment for formal physics. Such a piece is a device for demonstrating the laws of falling bodies. The only cheap thing for this is the inclined plane, and every physics teacher knows how unsatisfactory that is. This is largely because of the impossibility of getting either a true plane or a true incline, and also because of the personal equation in the manipulation. The Atwood's machine is expensive, if a first-class article is purchased, and the apparatus in which a tuning fork with a stylus traces vibrations on a blackened accelerated plate is more expensive still.

After wrestling with the inclined plane for three years in his present situation, the writer finally devised a crude and somewhat modified form of Atwood's machine, which not only eliminates the inherent imperfections of the inclined plane, but the personal element as well. A front elevation diagram is shown herewith.

Having the materials at hand in the laboratory, and the design well in mind, the apparatus was made complete in about two hours. It should be added that the magnet was already wound, having been taken from a discarded program clock. But the winding could easily be done by hand by taking more time.

In the figure *U* is a soft pine board 4 in. wide and cut 7 ft. long. At the top and at one side is *p*, an ordinary cone-bearing, wooden, laboratory pulley, of about 50 mm. diameter. This pulley should preferably be of brass, as it must form part of an electric circuit. Not having a brass pulley at hand, the writer simply covered the rim of the wooden pulley very carefully with tinfoil, sticking with liquid glue, and rubbing the foil smoothly down into the groove with a nail of suitable size. Then a strip on one side, from circumference to cone hub, completed the

metallic circuit. The pulley is supported upon a very stiff piece of brass wire, or rather small rod, *l*, threaded at one end, about No. 6, and stapled to the top of the board. The supporting end passes through holes always in the frames of these pulleys.



E is a small, U-shaped electromagnet, about 2 in. in length, with an armature, *a*, supported on a short rod working in a suitable collar. By means of a strap, *h*, and set screw in the middle of it, the magnet is not only held in place, but its working distance from its armature is adjustable. At the lower end of the rod attached perpendicularly to the armature is an eye, *e*, the use of which will presently appear.

At *S* is a supporting platform, or stage, which consists merely of a brass hinge, one leaf of which is screwed to the board, the other having attached a strip of ordinary tinned iron about 1½ in. wide and 3 in. long. This stage is held in a horizontal position by the trigger, *T*, which is pivoted near its middle. The upper end of this trigger is fastened, by means of a fine wire, to the eye, *e*, of the rod attached to the armature. String or thread could be used here, but a wire is less likely to acquire excessive "lost motion" by use. The scale, *L*, is simply two meter sticks screwed fast to the board with their proper ends together.

R is the receiving stage, and consists of a cylindrical tin box about 6 cm. deep and 10 cm. in diameter. It, together with a screw clamp, is permanently screwed to a sliding piece of wood. The receiving stage is necessarily of metal, because it is also part of an electric circuit. This platform is adjustable anywhere up and down the scale. It was best to have a platform with walls in order to prevent the falling weights from rebounding off it and getting tangled with the other strand of the supporting wire.

The battery and seconds pendulum, together with the necessary circuits, are shown in the figure. As the supporting wire used is quite fine, and the resistance of the contacts is in some cases rather high, the battery pressure should not be less than 6 volts, while eight or ten would perhaps be better. The writer uses a battery of 16 Edison primary cells in series, and carries a number of pieces of wall apparatus on it, and does not find the resulting 12 volts inconveniently high.

The operation of the machine is as follows: Consider the weight, *M*, with its overweight, *w*, on the stage, *S*. The counter weight *M'*, is at the other end of a piece of No. 32, B. & S., bare copper wire, which runs over the pulley, *p*. The counter weights are 50 g. each, while the overweight is 5 g., although this latter is by no means fixed. The pendulum is now set in motion, and the mercury turned up in the well, *D*, thus starting the sounder, *s*, both sounder and pendulum being in series with each other and with the battery. The little electromagnet, *E*, is connected in parallel across the binding posts of the sounder, and one side of its circuit is broken by the switch, *Q*. When this switch is closed it is obvious that the pendulum controls the circuit through the magnet. Therefore the armature, *a*, is snapped up, jerking the trigger, *T*, and releasing the platform, *S*, practically at the instant the sounder clicks at the beginning of a second.

Since the weights are brass and are supported by a copper wire, they may be made part of a recording circuit. Therefore the pulley, supporting wire, receiving platform, and a watch case telephone receiver, N, are put in series with each other across the parallel wires from the sounder. Therefore the receiver, which is held to the ear of the operator, will click at the instant the falling weights, M and w, strike the receiving platform, *only* when this contact is exactly coincident with the click of the telegraph sounder, or in other words, with the passing of the pendulum point through the mercury, as only then can there be a current in the circuit.

Thus it is seen that a dependence on the ear of the operator for a coincidence on the receiving platform is eliminated.

To be sure there are certain inherent sources of error in the apparatus, preventing the securing of an absolutely correct ratio. One of these is, of course, the time lost in the armature and trigger system in moving through the space necessary to release the platform. Still another is perhaps the somewhat variable flexibility of the wire. But on the whole the results have been fairly satisfactory for a high school laboratory, most of the students securing the proper ratios within two or three millimeters. Collaboration of results is prevented by changing the weights from day to day.

It is not easy to make an estimate of what the construction of this apparatus would cost, even assuming that the instructor already has his seconds pendulum and proper battery equipment. But it is safe to say that the actual cost of the materials, exclusive of the ones just named, would not aggregate more than two dollars and a half. ($2.50.)

ASBESTOS PRODUCTION.

Nearly all the asbestos produced in the United States during 1909 was mined in Vermont and Georgia, though a small quantity came from Idaho and Wyoming. The total output was 3,085 tons, a 200 per cent increase over the output of 1908. The general average in value was slightly higher, owing to the increased output of the chrysotile variety. The outlook for increased production is especially encouraging in Vermont and Wyoming. Mills have been started this year in the latter state. The imports of raw asbestos, principally from Canada, were 1,021,390 tons. The Canadian production amounted to 2,284,587 tons, to which may be added 23,951 tons of asbestic, an inferior by-product.

THE TEACHING OF MATHEMATICS IN THE PRIVATE SECONDARY SCHOOLS OF THE UNITED STATES.

The following article is a report (slightly condensed) recently submitted to the American Commissioners of the International Commission on the Teaching of Mathematics by the Committee on Private General Secondary Schools.

Plan of the Investigation.

The field assigned to the Committee includes schools connected with religious organizations, and preparatory departments of colleges, but not special schools, such as trade schools and schools for defectives. The members of the subcommittees were selected with a view to having representatives of various types of schools and, to some extent, of different sections of the country.[1]

[1]WILLIAM E. STARK, *Chairman*,
Principal High School Department, Ethical Culture School, New York City.
JOHN S. FRENCH, *Chairman Sub-Committee on Boys' Schools*,
Principal Morris Heights School, Providence, R. I.
S. A. COURTIS, *Chairman Sub-Committee on Girls' Schools*,
Director of Mathematics and Science, Home and Day School, Detroit, Mich.
C. N. NEWHALL, *Chairman Sub-Committee on Coeducational Schools*,
Director of Mathematics, Shattuck School, Faribault, Minn.

Sub-Committee on Boys' Schools.

WALTER R. MARSH, Principal St. Paul's School, Garden City, N. Y.
J. L. PATTERSON, Principal Chestnut Hill Academy, Philadelphia, Pa.
WILLIAM R. SCHWARZ, Cathedral College, New York City.
JOSIAH BARTLETT, Riverview Academy, Poughkeepsie, N. Y.
FRANKLIN T. JONES, University School, Cleveland, O.
WILLIAM HUGHES, Principal Branham and Hughes School, Spring Hill, Tenn.

Sub-Committee on Girls' Schools.

EMMA M. COWLES, Milwaukee Downer College, Milwaukee, Wis.
SARAH M. LAKE, Miss Winsor's School, Boston, Mass.
RUTH G. WOOD, Smith College, Northampton, Mass.
HARRIOT D. BUCKINGHAM, Girls' High School, Lexington, Mass.
VIRGINIA RAGSDALE, Baldwin School, Byrn Mawr, Pa.
VEVIA BLAIR, Sachs School for Girls, New York City.
REV. BROTHER POTAMIAM, Manhattan College, New York City.

Sub-Committee on Coeducational Schools.

G. H. ALBRIGHT, Colorado College, Colorado Springs, Colo.
E. R. BRESLICH, University High School, University of Chicago, Chicago, Ill.
GEORGE P. TIBBETTS, Williston Seminary, East Hampton, Mass.
E. J. OWEN, Pillsbury Academy, Owatonna, Minn.
LAURA A. WHYTE, Norwich Free Academy, Norwich, Conn.

Method of Collecting the Data.

The only publications to which the committee has found it desirable to refer are the annual reports of the United States Commissioner of Education, from which statistics in regard to organization of schools have been taken. At the beginning of the investigation catalogs of several hundred schools were examined without finding anything of value for the purpose in hand. As the private schools in the United States are subject to no centralized control, no comprehensive view of their organization or of the character of their work could be obtained except by applying to the schools themselves for the information. The method of the questionnaire seemed to be the only one available.

A questionnaire, referred to in the report as the principal questionnaire, was sent, by the United States Commissioner of Education, in behalf of the committee, to all the schools of the country[2] within the committee's field. A supplementary questionnaire covering additional topics was sent by the committee to a limited number of schools selected so as to include different types, sizes, and locations.

Preparation of the Report.

The returns from the questionnaires were studied by the subcommittees and reports were prepared by the chairmen. Separate reports upon the fields represented by the subcommittees would involve so much repetition that it has seemed best to combine all the data in a single report indicating, whenever an important distinction appears, the variation in the practice of the different types of schools.

The report aims to give a general view of the conditions under which mathematics is taught in the private secondary schools of the country. It has obviously been impossible through the method employed, to obtain a thorough knowledge of the character of the teaching. It would have been possible to make a searching examination of a few schools and to report interesting experiments which are being conducted in certain institutions. That, however, would not have served the purpose of the investigation as understood by the committee. Instead, we have confined ourselves to commonplace questions, and attempted to secure answers as accurate as possible for the whole field. In order to give a true picture of conditions, an average value is

[2]The expression "all the schools," used frequently in the report, means all the schools in the records of the U. S. Commissioner of Education.

usually amplified by a description of the variation in practice with regard to the point in question.

Extent and Character of the Data.

THE PRINCIPAL QUESTIONNAIRE.

The principal questionnaire brought, in time for use in the report, replies from 418 schools, or twenty-three per cent of all the schools in the country belonging to the field to be studied. The numbers of replies representing different types of schools and the percentage of the total numbers of the schools of the various types are as follows:

Type of School	Number of Replies	Percentage of all Schools of the Type
Preparatory departments of colleges—		
For boys	25	
For girls	20	
For both sexes	47	
Total	92	19
Independent secondary schools—		
For boys	98	35
For girls	94	26
For both sexes	134	20
Total	326	25
In New England*	68	33
Middle Atlantic States	93	30
South Atlantic States	42	20
South Central States	28	14
North Central States	78	27
Western States	17	18
Roman Catholic schools	59	16
Other religious schools	94	24
Nonsectarian schools	173	32

The number and percentage of replies with regard to nearly every group of schools referred to would be large enough to give a satisfactory indication of the general character of all the schools of the group, if the schools replying were selected at random. It is natural to suppose that a larger percentage of

**New England*—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.

Middle Atlantic States—New York, New Jersey, Pennsylvania.

South Atlantic States—Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida.

South Central States—Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Arkansas, Oklahoma.

North Central States—Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas.

Western States—Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, California.

schools of high grade than of less efficient schools would respond to the questionnaire, but it is impossible to say to what extent this supposition is justified. A slight clue to the representative character of the returns may be gained by comparing the size (number of pupils) of the schools reporting with the average size of all the schools. The average enrollment for all the independent private secondary schools for the year 1908-09 is given in the latest published report of the United States Commissioner of Education. As the statistics reported in returns to the questionnaire are for the year 1909-10, the figures are not strictly comparable, but any marked tendency toward the exclusion of the smaller schools would be evident by such a comparison. The respective average enrollments of the reporting schools and of all the schools included in the commissioner's report for 1909 are: for boys' schools, 93 and 82; for girls' schools, 62 and 60; and for coeducational schools, 91 and 75.

The correspondence between the two sets of figures, taken with the fact that the reported enrollments exhibit a very wide variation, indicates that, while the smaller schools are somewhat less generally represented than the larger ones, a fairly true picture of the general tendency and variability in this one respect may be gained from the reports. The figures in regard to many other details of organization indicate such definite tendencies with such regular variation toward the extreme values that they too would seem to be fairly representative.

The Supplementary Questionnaire.

The supplementary questionnaire brought about one third as many replies as the principal questionnaire. The coeducational schools were poorly represented and the proportion as well as number of schools from the North Atlantic States was much higher than for other sections of the country. The replies include only four Roman Catholic schools and very few preparatory departments of colleges. The proportion of very small schools is much lower than in the returns to the principal questionnaire.

The data obtained from the supplementary questionnaire should not, therefore, be regarded as representative to the same degree as that of the principal questionnaire. The replies to questions of opinion are valuable only as indications of the consensus and variation of opinion among teachers representing chiefly the larger schools in the more populous and wealthy sections of the country.

Following are the numbers of replies from the various groups of schools:

Boys' schools	43
Girls' schools	59
Coeducational schools	37
Total	139[3]
Religious schools	58
Nonsectarian schools	79
Schools situated in—	
New England	31
Middle Atlantic States	51
South Atlantic States	13
South Central States	11
North Central States	27
Western States	4

Other Sources of Inaccuracy.

Many replies to both questionnaires were incomplete and some were obviously incorrect. In general, ambiguous answers and those indicating a misunderstanding of the question have been excluded. In the presentation of each topic is given the number or proportion of the replies upon which the statement is based.

In order to reduce the labor of filling out the questionnaire blanks, many questions were so presented that answers could be given by crossing out items from a list of possible replies. Where the items given are not alternatives, this method is likely to cause error through the failure of the reporting officer to cross out every inappropriate item. Note of this source of inaccuracy is made in the presentation of topics in which it is pertinent.

Organization of Private Secondary Schools.

Types of Schools.[4]

During the Colonial period, the American secondary schools were "Latin grammar schools" whose function it was to prepare boys for college. During the first half of the nineteenth century the typical secondary school was the academy. It was only in-

[3]Two anonymous reports could not be included in the classifications according to location and religious connection.

[4]The first paragraph is based upon a monograph on Secondary Education by Elmer Ellsworth Brown in a series of monographs on Education in the United States, edited by Nicholas Murray Butler, Albany, 1900. The second paragraph is based upon the author's observation combined with returns from the questionnaires.

cidentally a preparatory school and furnished a broad general course of study. Many of these schools were endowed and a low tuition fee, or in some cases free tuition, made it possible for children from families in moderate circumstances to attend. Some of the academies were for boys, others—usually called "female seminaries"—for girls, but many were coeducational. They usually provided for boarding students. Many of them were under the control of religious bodies. With the rapid development of the public high schools during the latter half of the nineteenth century, many of the academies ceased to exist or were transformed into public schools. Others became more distinctively preparatory schools.

The private secondary schools of the present day include the following fairly well marked types: (1) The surviving academies and other more recently organized schools of the same type, including many of the schools connected with religious organizations. (2) Private schools having relatively high tuition fees, usually for one sex. The cities, especially those in the North Atlantic States, usually have day schools of this grade. The boarding schools are ordinarily in the country or in small towns. (3) Preparatory departments of colleges. (4) Secondary departments of elementary schools, including many Roman Catholic schools for girls. There are also a few large, finely equipped coeducational schools maintained in connection with the departments of education of some of the larger universities, or supported by other organizations for the purpose of contributing to progress in education.

CLASSIFICATION OF SCHOOLS ACCORDING TO SEX OF PUPILS.

Of the 1,031 independent private secondary schools reporting for the year 1908-09 to the United States Commissioner of Education, twenty-one per cent were for boys only, twenty-eight per cent for girls only, and fifty-one per cent were for both sexes. Of 422 preparatory departments of colleges (not including those under state control), twenty-one per cent were for boys, the same percentage for girls, and fifty-eight per cent were coeducational. (See Fig. 1.)

GEOGRAPHICAL DISTRIBUTION.

The Middle Atlantic and the North Central sections have each about three hundred of the independent schools; New England, the South Atlantic, and the South Central sections have each

about two hundred, and nearly one hundred schools are in the Western States. The proportion of boys' schools is relatively

Classification of 1,031 Private Secondary Schools of the United States, 1909.

FIG. 1

high in the eastern part of the country, and that of the girls' schools in the North Central and Western States. About half of the schools in each section of the country are coeducational except in the South Central and Western States where the coeducational schools form respectively sixty-five per cent and thirty-four per cent of the total. Practically none of the New England colleges have preparatory departments and there are comparatively few in the Middle Atlantic States. In the other sections of the country, however, the colleges commonly have such departments, and in the North Central States alone there are 180 of them. A majority of these preparatory departments are coeducational but in the Southern States there are many connected with colleges for women.

RELIGIOUS CONNECTION.[5]

Twenty-nine per cent of the independent private secondary schools are controlled by the Roman Catholic Church, and thirty per cent are connected with other religious denominations. Fig. 1. Thirteen per cent of the preparatory departments of colleges are Roman Catholic and sixty-nine per cent are connected with other churches. Two-thirds of the schools in New England are non-sectarian, while in other sections of the country the majority

[5]It is safe to say that many schools reported as religious schools are subject to no *control* by religious organizations. We have no means of separating these schools from those properly classified as religious institutions.

are religious schools. The Roman Catholic schools for girls are very numerous in the Central and Western sections, forming seventy per cent of all the girls' schools in that region. A majority of the Roman Catholic schools for boys are connected with colleges; fifty of the eighty-eight preparatory departments for boys are Roman Catholic. Sixty per cent of the independent schools and seventy per cent of the preparatory departments connected with other religious denominations are coeducational.

DAY SCHOOLS AND BOARDING SCHOOLS.

Of 404 schools reporting on this point in answer to the principal questionnaire, thirty-one per cent are day schools, ten per cent boarding schools, and fifty-nine per cent take both day and boarding pupils. The same order holds in all three classes of schools (boys', girls', and coeducational) and in all sections of the country; that is, the greatest number take both day and boarding students and the schools for boarders only are least numerous. There are very few schools for day pupils only in the South and West.

AGE OF SCHOOLS.

Three hundred and eighty-eight schools replying to the principal questionnaire gave the date of establishment (or that of the secondary department). The ages range from one year to 265 years, a few of the oldest preserving the name "Grammar School." Twenty-one of the schools are over one hundred years old, including some of the oldest academies. Only sixteen have been established within five years. The median age of the boys' schools lies between forty years and fifty years, that of the coeducational schools between thirty and forty, and that of the girls' schools between twenty and thirty. Thirty-seven per cent of the boys' schools and thirty-four per cent of the coeducational schools are over fifty years old, while only nineteen per cent of the girls' schools are as old as this.

NUMBER OF PUPILS.

In 1908-09[6] the average enrollment in the independent private secondary schools was, in boys' schools, eighty-two; in girls' schools, sixty, and in coeducational schools thirty-six boys and thirty-nine girls. The variability in the size of schools may be judged from the following table based on 345 replies, although

[6]Report of U. S. Commissioner of Education, 1909.

the average enrollment in these schools is about eighteen per cent higher than that of all the schools referred to above.

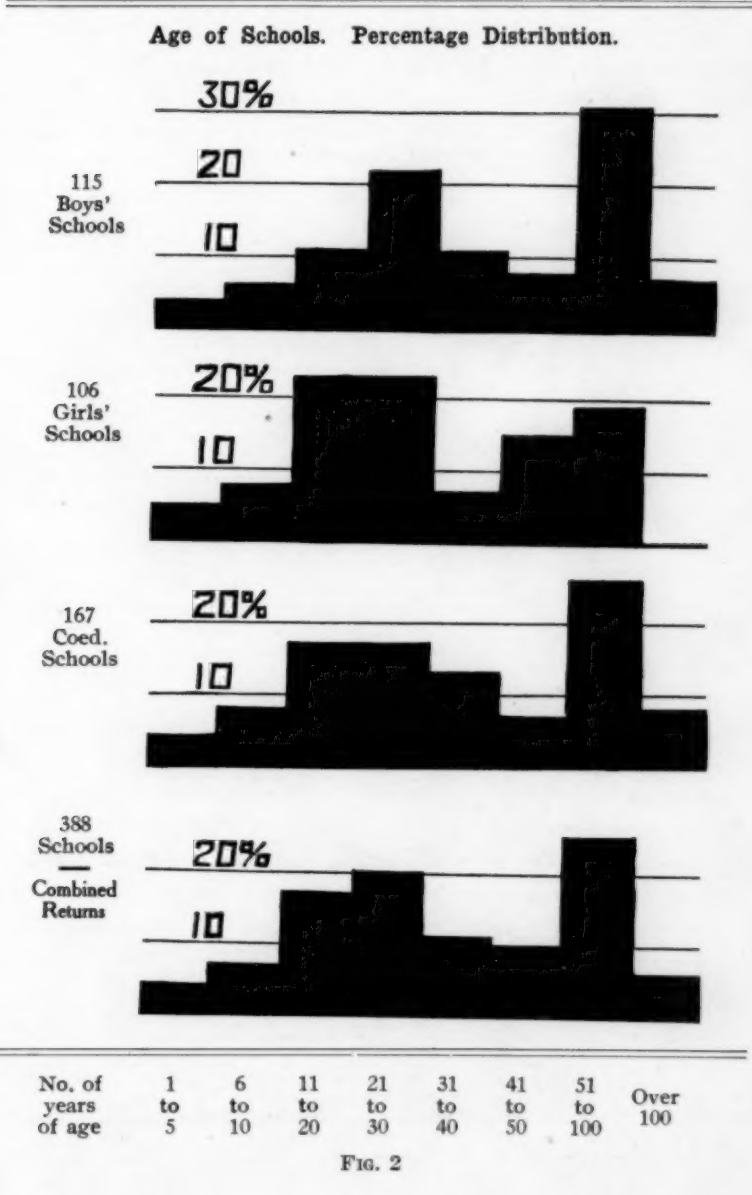


FIG. 2

DISTRIBUTION OF 345 SCHOOLS, INCLUDING PREPARATORY DEPARTMENTS OF COLLEGES ACCORDING TO NUMBER OF PUPILS.

Enrollment	More than 500	401 to 500	301 to 400	201 to 300	101 to 200	51 to 100	50 or less	Total No. of Replies
Boys' schools		1	3	7	24	30	36	101
Girls' schools				1	11	23	45	80
Coed. schools	2	1	6	12	44	33	66	164
All schools	2	2	9	20	79	86	147	345

Sizes of Schools. Percentage Distribution.

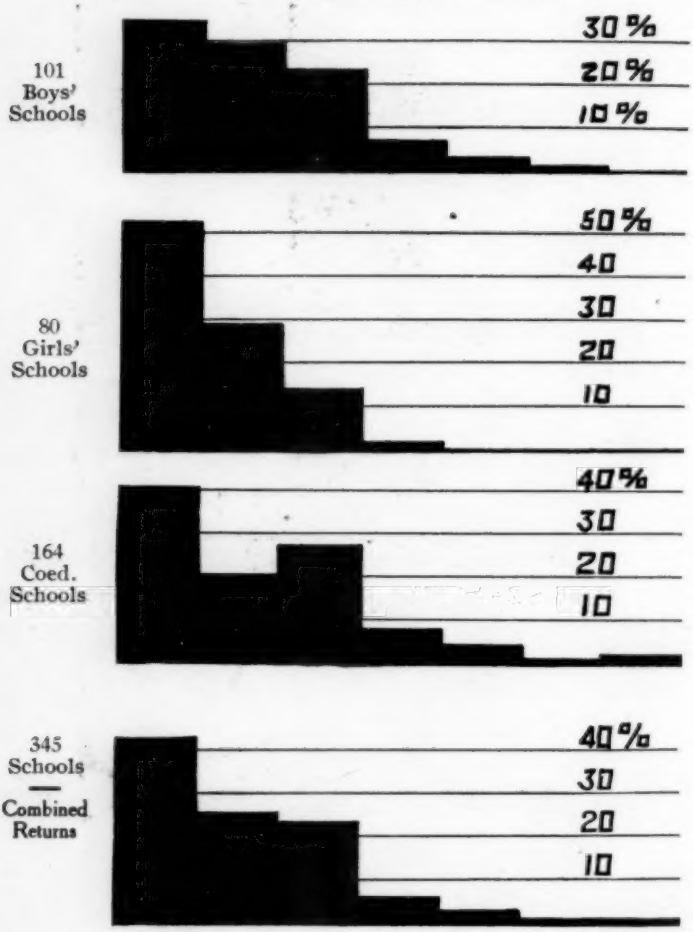


FIG. 3

The two largest schools which have respectively 1,048 and 580 pupils are both coeducational day schools and are connected with higher institutions, situated in one of the largest cities in the country. The largest boys' school, with an enrollment of 500, is an independent secondary school—one of the old academies—located in a small town in New England and taking both day and boarding students. The largest girls' school reporting its enrollment has 216 pupils. It is an independent day school in a New England city of moderate size.

It will be noticed that more than half of the girls' schools and forty-two per cent of all schools had not more than fifty pupils each. Eighty-five per cent of the girls' schools had not more than one hundred pupils each, and in ninety per cent of all the schools the enrollment was not over two hundred.

NUMBER OF PUPILS PER TEACHER.

In 1905-06[7] the average number of pupils per teacher in all the independent private secondary schools was as follows: For girls' schools, 6.9; for boys' schools, 10.4; and for coeducational schools 14. The variability of the number of pupils to one teacher for 342 schools[8] is shown below.

No. of Pupils per Teacher	46 to 50	41 to 45	36 to 40	31 to 35	26 to 30	21 to 25	16 to 20	11 to 15	6 to 10	5 or less	Total No. Reports
No. of boys' sch.					3	6	10	32	42	12	105
No. of girls' sch.						2	7	15	37	25	86
No. of coed. sch.	2	3	2	2	5	15	27	57	31	7	151

Eighty-two per cent of the boys' schools and ninety per cent of the girls' schools have not more than fifteen pupils per teacher, while only sixty-three per cent of the coeducational schools come within this limit. The nine coeducational schools in which the ratio is higher than thirty pupils to one teacher are nearly all in the Southern States.

LENGTH OF SCHOOL YEAR.

The length of the school year as reported by 407 schools is as follows:

With the exception of one school which has only a single year of secondary work, the minimum school year was twenty-five weeks in a small coeducational day school in New York City. The maximum reported by three schools was forty-two

[7] Report of the U. S. Commissioner of Education, 1906. This is the most recent report giving detailed statistics of secondary schools.
[8] Data of principal questionnaire.

weeks. Sixty-four per cent of the boys' schools, fifty per cent of the girls' schools, and eighty-seven per cent of the coeducational schools have a year of from thirty-six to forty weeks. All but thirteen out of 407 schools have more than thirty weeks. Most of the schools with a very short year are girls' schools in the East. The Roman Catholic schools commonly have forty weeks. The school year is shorter in the East than in the Central and Western sections; forty-one per cent of the Eastern schools have a year of thirty-five weeks or less, while in the rest of the country only fifteen per cent of the schools reporting have so short a year.

CONNECTION WITH OTHER DEPARTMENTS.

Among the 418 schools replying to the questionnaire, elementary departments are maintained by sixty per cent of the boys' schools, seventy-nine per cent of the girls' schools, and forty-four per cent of the coeducational schools. In boys' schools the elementary department is as a rule relatively small, and in girls' schools and coeducational schools the same is true in a majority of cases, but many of the Roman Catholic schools for girls and for both sexes have large elementary departments with comparatively few secondary students. As already stated, twenty-two per cent of the schools replying are connected with colleges. Besides these, about one sixth of the schools give some work of collegiate grade.

COURSES OF STUDY.

Practically all the schools offer college preparatory courses. About twenty per cent of all the schools offer only a single course —usually planned to meet college requirements—although some choice of studies within this course is often allowed. This practice (single course) is commonest in boys' schools and least common in girls' schools. A more general plan is to offer two courses, a college preparatory course and either a scientific course, a general course, or a commercial course. Many schools differentiate more widely, offering three, four, or even five courses. In 1908-09 twenty-nine per cent of the boys and ten per cent of the girls enrolled in independent private secondary schools were preparing for college. A majority (fifty-three per cent) of these boys were in scientific courses, while seventy-one per cent of the girls were in classical courses. Sixty-one per cent of the boys and twenty-three per cent of the girls in the

graduating classes intended to enter college. Commercial courses are given in comparatively few (about one-fifth) of the girls' schools. Most of the Catholic schools for boys give commercial courses, and a relatively large proportion of the Catholic schools for girls give such courses.

Except for commercial students, four years is ordinarily the length of the secondary course, pupils entering at about fourteen years of age. About an equal number of schools—seven or eight per cent of all—have courses of three years and five years respectively, and a few schools make six years the normal period. The schools whose courses are longer than four years, usually admit pupils at an earlier age than the others, or give work in advance of the requirements for admission to college. Among the schools which maintain elementary departments, there may be little real distinction between those which report a secondary course of six years and those which label only four of those years "secondary." Commercial courses vary in length from one to four years. In the boys' schools four years is the common length, and in girls' schools two years, while in the coeducational schools four years' and two years' courses are about equally common.

The Department of Mathematics.

NUMBER AND SEX OF MATHEMATICS TEACHERS.

In the replies to the principal questionnaire, about ninety per cent of the boys' schools and coeducational schools and seventy-five per cent of the girls' schools gave lists of their teachers of mathematics with the courses taught by each teacher. The records of about eight hundred teachers are included in these reports.

In the boys' schools, practically all the classes in mathematics are taught by men, in the girls' schools ninety-three per cent of the teachers are women, while in the coeducational schools sixty-three per cent are men.

In about one third of the schools reporting, the work in secondary mathematics is done by a single teacher, who as often as not teaches other subjects also. Several of the large boys' schools have as many as eight teachers giving all their time to mathematics.

TEACHERS' ASSIGNMENTS.

About thirty per cent of the teachers teach only mathematics

and give at least two hours a day to teaching. About sixty per cent are reported as teaching other subjects also. In the remaining cases, only mathematical courses are listed, but as only one or two courses are assigned to each teacher, it is probable that many of these teachers have other teaching assignments which were not recorded. In the Roman Catholic schools it is the common practice to divide the work in mathematics among several teachers, each of whom teaches several other subjects.

In the list of subjects other than mathematics assigned to mathematics teachers, every subject in the curriculum appears. Those most frequently mentioned are, in order: natural science (especially physics), Latin, modern languages, and commercial subjects.

About one eighth of the teachers have classes in mathematics in elementary or collegiate departments as well as work of secondary grade.

The returns giving the amounts of time required of teachers in teaching and in other school duties are not sufficiently reliable to warrant a quantitative statement. They indicate a very wide variation, some teachers giving only a single course while others are reported as teaching an incredible number of hours. As illustrations of practice in some of the well-known schools whose reports were evidently made with care, the following figures are given; but it is not intended to imply that they are typical.

SCHOOL	No. of Minutes of Teaching	No. of Minutes of other duties
1. A boys' boarding school in Pennsylvania	675 to 950, av. 876	400 to 1150, av. 690
2. A boys' day school in New York City	1200 to 1400, av. 1270	250 to 460, av. 390
3. A girls' boarding school in California	765	460
4. A girls' day school in Massachusetts	640 to 960, av. 800	465 to 785, av. 625
5. A coeducational boarding school in Ohio	1200 to 1380, av. 1280	None Required
6. A coeducational day school in Chicago, Ill.	1000 to 1250, av. 1050	None

TEACHERS' SALARIES.

About sixty per cent of the replies from boys' schools and coeducational schools reported facts in regard to the salaries of mathematics teachers doing secondary work. Only forty-four

per cent of the girls' schools reported salaries. The reports from Roman Catholic schools, with very few exceptions, stated that their teachers receive no salaries but are supported by the religious orders to which they belong.

The questionnaire called for maximum, minimum, and average salaries in order to secure data on the variation within the schools which have several teachers. In some cases the maximum only was given, in some the minimum, and in others the average. Some of the replies showed that the question was understood to call for variation in a single teacher's salary according to the schedule of salaries in force in the school.

The figures, therefore, are probably not as reliable as most of the data presented. They will serve, however, to indicate in a general way the distribution of salaries in different types of schools and in different sections of the country. In the following figures, the salaries of principals who are also teachers of mathematics, and those of teachers receiving board as a part of their remuneration, have been excluded.

In the boys' schools, the salaries reported vary from $50 per month to $2,700 per year. Ten schools reported a maximum salary of $2,000 or over. Of the thirty-nine schools reporting an average salary or the salary of a single teacher, twenty-five reported sums lying between $600 and $1,200 and the rest with one exception between $1,300 and $2,000.

In the girls' schools, the lowest salary reported was $40 per month. Only one school—a day school in New York City—gave a sum higher than $1,200. In this the maximum is $2,000. Sixteen of the thirty schools which report an average salary, place this between $700 and $1,000.

In the coeducational schools, the figures range from $35 per month to $2,500 per year. Besides the one reporting this maximum, only one school has a maximum as high as $2,000. Ten have maximum salaries ranging from $1,200 to $1,800. Eighty coeducational schools gave an average salary. In more than half of these, the sum varies from $500 to $800. In twenty of the eighty schools it lies between $800 and $1,200.

The average of the salaries reported as the salary of a single teacher or the average of the salaries of all mathematics teachers in a school is, for boys' schools between $1,100 and $1,200; for girls' schools between $700 and $800; and for coeducational schools practically the same as for girls' schools.

On the whole, the salaries reported from schools of the North

Atlantic States are considerably higher than in other parts of the country, although the few schools representing the far West give figures closely corresponding to those in the North Atlantic States.

Salaries of Mathematics Teachers. Percentage Distribution.

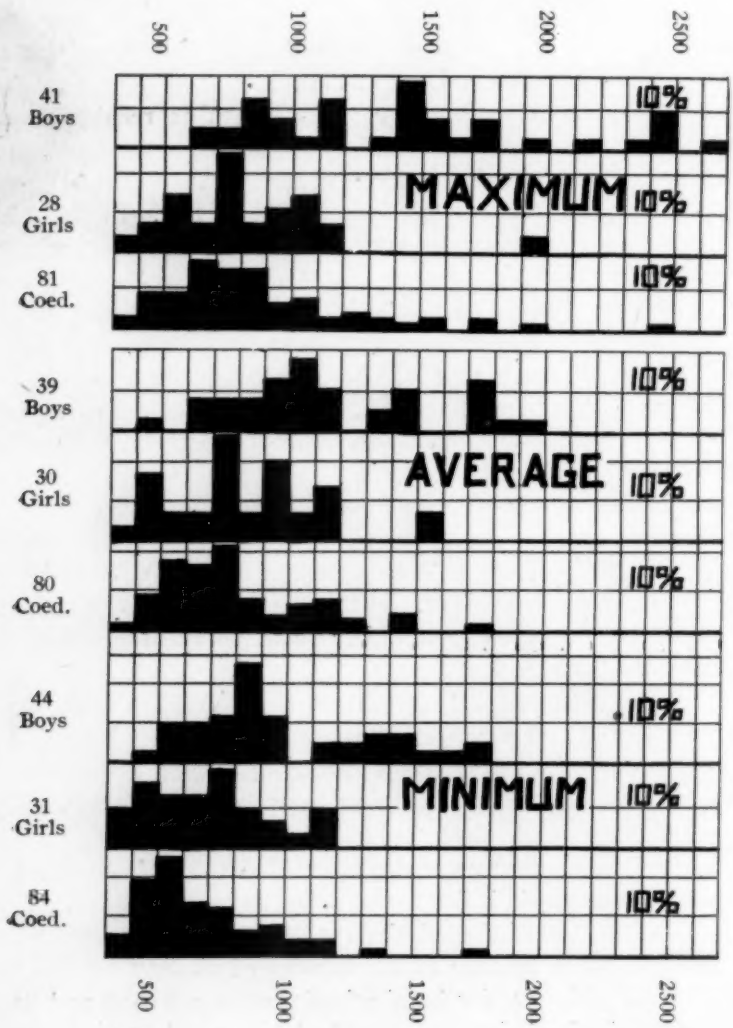


FIG. 4

ACADEMIC AND PROFESSIONAL TRAINING OF TEACHERS.

The supplementary questionnaire called for data in regard to the training and professional experience of teachers of mathe-

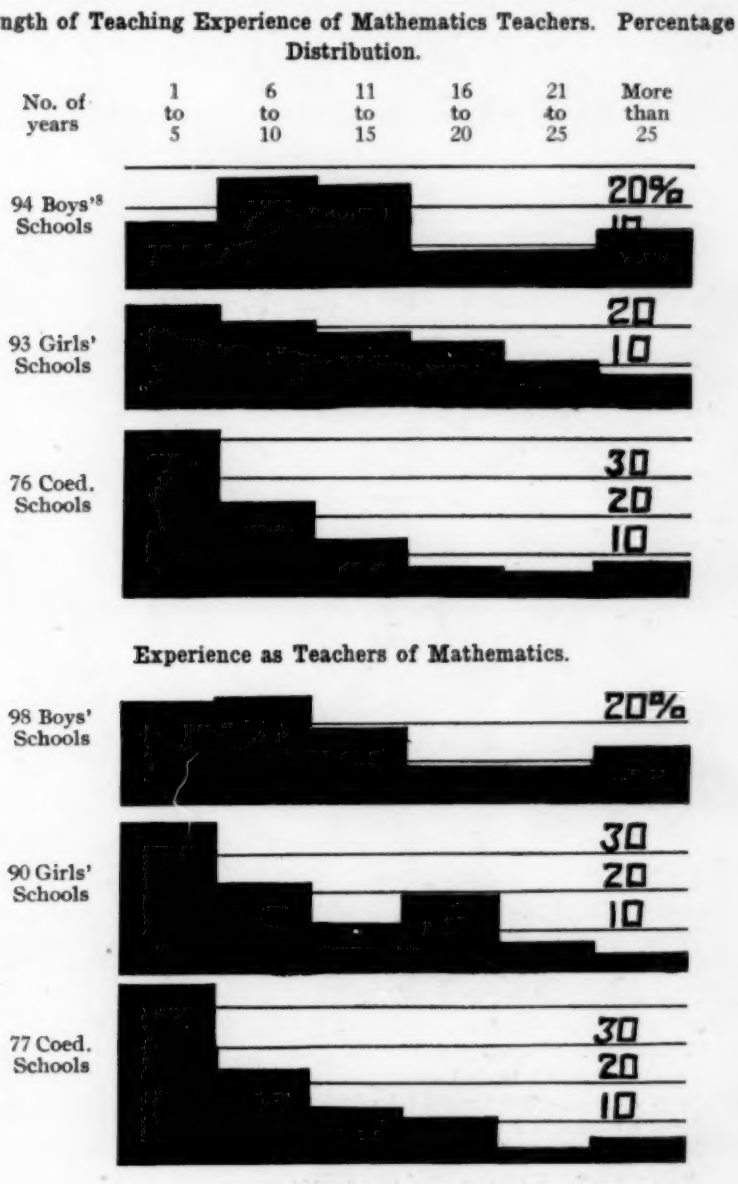


FIG. 5

[8]94 Boys' Schools means 94 teachers connected with boys' schools.

matics. The replies represent 146 schools with 282 teachers. As one would expect, the teachers referred to in the reports from boys' schools are practically all men and from the girls' schools women. There is a much larger proportion of male teachers in the coeducational schools reporting than in coeducational schools generally.

The following table gives a distribution of the teachers for whom data were reported according to total length of experience in teaching and also according to length of service as teachers of mathematics.

Years of Experience in Teaching	Distribution of Teachers by years of experience in Teaching			Distribution of Teachers by years of experience in teaching Mathematics		
	Boys' Schools	Girls' Schools	Coed. Schools	Boys' Schools	Girls' Schools	Coed. Schools
1 - 5 years	15	24	32	25	34	35
6 - 10 "	26	20	18	26	20	18
11 - 15 "	24	17	11	18	10	10
16 - 20 "	8	15	5	8	17	8
21 - 25 "	8	10	4	8	6	2
Over 25 "	13	7	6	13	3	4
Total	94	93	76	98	90	77
Average	14.0	12.6	9.7	12.8	10.5	9.1

It appears that thirty-five per cent of these teachers have taught mathematics not more than five years and nearly sixty per cent not more than ten years. The average length of service is greatest in the boys' schools and least in the coeducational schools.

The facts relating to the academic and professional education of the teachers reported are, in brief, as follows:

ACADEMIC EDUCATION	BOYS' SCHOOLS	GIRLS' SCHOOLS	COED. SCHOOLS
Number of teachers reporting	101	92	79
Number having Doctor's degree	3	0	2
Number having Master's degree (no higher)	22	12	21
Number having Bachelors' degree (no higher)	58	53	46
Total number holding degrees	83	65	69
Number having partial college education (not including summer school work)	9	6	3
Number having full normal school course	2	3	0
Number having partial normal school course	0	5	2
Number having full high school course	3	4	3
Number having partial high school course	1	4	1
Number mentioning no academic training	3	5	1
Total number not holding degrees	18 (18%)	27 (29%)	10 (13%)

Eighty per cent of all the teachers for whom the data were given were holders of degrees. The proportion is not as high (about 70%) for teachers in girls' schools as for those in schools for boys and for both sexes, and a smaller portion of degree holders teaching in the girls' schools have taken a second degree than is the case among teachers in the other institutions.

About half of the holders of degrees report academic or professional training in addition to that required for a degree, the proportion being highest in schools for girls. Of the teachers in girls' schools who have received no degree, nearly all have had some definite professional education, or academic work of collegiate grade.

Seventeen of the male teachers have had training for other professions: four law, two theology, one medicine, one agriculture, and nine engineering.

DIRECTION OF THE DEPARTMENT OF MATHEMATICS.

In a small majority of the schools replying to the principal questionnaire, the work in mathematics is directed by the principal who, more often than not, teaches some of the classes in mathematics. In Roman Catholic schools, the principal usually directs the work and does not often teach mathematics.

In the other schools one of the teachers of mathematics usually acts as director, but in the preparatory departments of colleges, one of the college teachers frequently supervises the preparatory work. Usually, but not always, he teaches some of the classes in secondary mathematics.

In the boys' schools, the directors are men in all the schools reporting, in the girls' schools, one sixth of the directors are men, while in the coeducational schools, seven-eighths are men.

SIZE OF CLASSES.

About two thirds of the schools replying to the principal questionnaire gave the numbers of pupils in recitation sections in mathematics. These represent a very wide variation, a few classes having sixty to seventy pupils each, while many have less than five. In general the size of the school determines the size of the classes, comparatively few schools (about one-fifth of the boys' schools and coeducational schools and a smaller proportion of the girls' schools) having more than one section of a given class.

In schools having parallel sections the variation corresponds closely to that for all the schools, excepting at the extremes of

the scale. Few of these parallel sections have less than ten or more than thirty pupils. A comparatively large proportion of the girls' schools have very small divisions even when classes are divided. The largest schools (for boys and for both sexes), which have in some cases as many as eight parallel sections, organize recitation sections of about twenty-five pupils each.

The replies in which enrollments were clearly recorded included over 1,500 recitation sections, about 500 in boys' schools, 300 in girls' schools, and 700 in coeducational schools. On the

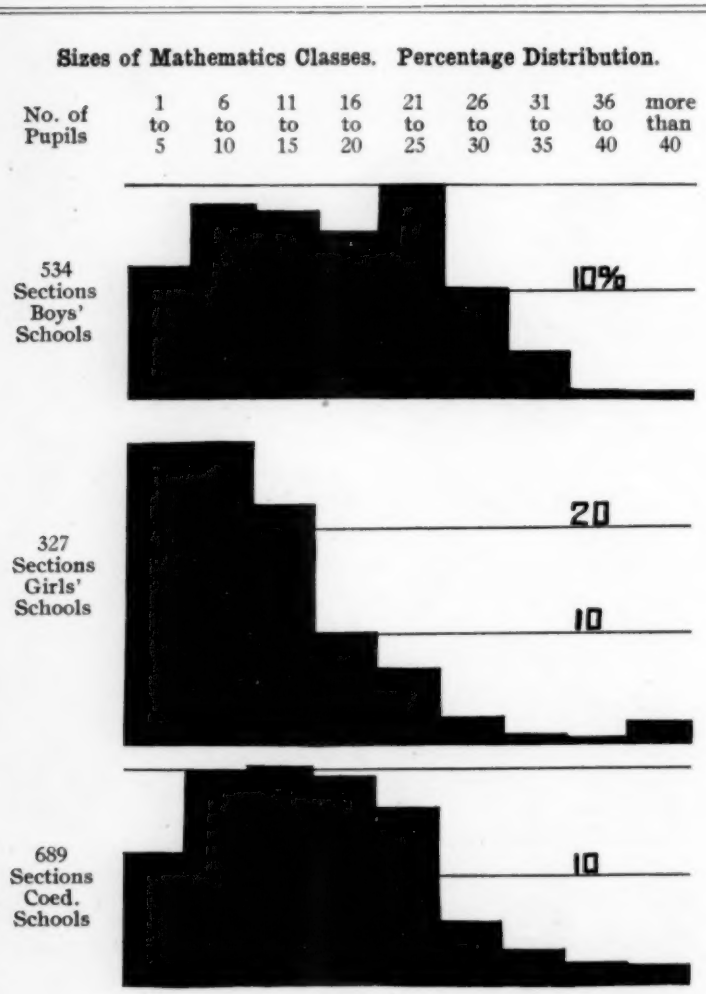


FIG. 6

whole the size of classes is about the same in the boys' schools and coeducational schools (average between sixteen and seventeen) and considerably smaller in the girls' schools (average eleven). Nearly thirty per cent of the sections from girls' schools have from one to five pupils each while only twelve per cent of the sections from other schools have as small an enrollment as this. About eighty per cent of the sections from girls' schools have not more than fifteen pupils each. About half of the other sections fall within this limit. From eighty-five to ninety per cent of all the divisions have not more than twenty-five pupils each.

TIME ALLOTMENT.[10]

Intelligible answers to the question in regard to the time allotment were given in about eighty per cent of the replies. The normal plan for mathematical courses is to have five recitations per week but four are not infrequently assigned, and some of the boys' boarding schools have six. In the North Atlantic States some schools have only three recitations per week.

The tendency is to reduce the number of periods in the later years of the course. In the last year where elective courses are common there is much variation and in many cases it is possible for a student's program to include seven or more periods in mathematical subjects. In scientific courses seven periods per week are sometimes required in the last year.

The length of the recitation period varies from twenty minutes to seventy-five minutes, but forty or forty-five minutes is the usual length.

GRADING AND PROMOTION OF PUPILS.[11]

In regard to the admission of pupils to the school, forty-one schools use no examinations but admit pupils on trial, on credentials from other schools, or—as in nearly all cases—on both conditions. Thirty-one schools use an oral examination in connection with credentials or trial or both, four use a written examination as the sole basis for admission, and fifty-nine use written examinations in connection with one or more of the other methods referred to. In ninety per cent of the schools some member of the mathematics department is consulted in regard to the grading of new pupils.

[10] Data of principal questionnaire.
[11] Data of the supplementary questionnaire.

Promotion in mathematics is independent of the standing in other subjects in eighty per cent of the schools reporting (about one hundred). In a few schools a pupil is not promoted in any subject unless he passes in all; in some cases promotion is based upon the pupil's average standing in all subjects; in others a pupil is obliged to repeat mathematics even though he has done well in it, if he fails in a certain proportion of his other work. Several say that standing in mathematics and English or mathematics and Latin determines promotion in all subjects.

No definite statements are made in regard to the bearing of those plans of promotion upon the effectiveness of the teaching in mathematical classes, but so far as this testimony goes, there would appear to be few instances in which teachers of mathematics are hampered by unsatisfactory grading of pupils. Some data in regard to examinations for promotion are given later in the report.

(The second half of this report will appear in the March issue.—Ed.)

In the Bulletin of the American Geographical Society for September, Professor Ellsworth Huntington makes a further contribution to the vexed question of climatic oscillations, which he has previously dealt with in his "Pulse of Asia" and other works. Writing of "The Libyan Oasis of Kharga," he finds that the habitability of this oasis, dependent upon its water supply, has fluctuated in long periods coincident with the similar periods or pulsations previously found for regions extending all the way from Egypt through Arabia, Persia, and Turkestan to the far confines of China, very roughly speaking, the oscillations of rainfall appear to have had a period of about five hundred years; and besides the alternation of dry and wet periods, there seems to have been a slow progressive decrease of rainfall from the earliest historic times to our own. It remains to be seen whether other parts of the world will be found to have had a similar climatic history.

In the Chem. Zentr., A. Heydweiller and F. Kopfermann describe a method of glass electrolysis. They have succeeded in introducing heavy metals into glass electrolytically by using fused salts of the metals as anodes. A small tube of soda or potash-glass, closed below, and containing a fused mixture of sodium and potassium nitrates to act as cathode, was immersed in the fused salt of the heavy metal acting as anode, and current was supplied by means of platinum wires. In this way, sodium, potassium, barium, strontium, tin, lead, copper, iron, cobalt, and silver were introduced into the glass at temperature above 200 deg. C.; successful results could not be obtained in the case of gold, platinum, and uranium. The metals penetrate the glass in the colloidal state, the color varying according to the conditions. On heating the colloidal solution is coagulated, the more noble metals separating as metal, while the baser metals separate in the form of oxides. Even without the aid of the electric current, metals diffuse into glass from their fused salts, but much more slowly than under the influence of electrolysis.

TWO EXPERIMENTS ON GRAMMAR SCHOOL GRADUATES.

By Peter G. Gartland,
English High School, Boston.

In September, 1909, the Boston English High School (for boys) established in Roxbury an overflow colony for entering class pupils. Given charge of this colony, I took occasion on the first school day to subject the 140-odd boys present to an examination in arithmetic.

For the purposes of this my first investigation, the papers of three of the four sections were examined. The papers of the fourth section had been thrown away after an examination by the room teacher, who did not know that I wished to study them. There is no reason, however, to suppose that they were on the whole any better or any worse than the papers saved for my personal scrutiny. For convenience five of the 105 papers left were discarded—one because there were no marks of identification upon it, one because it was produced by a boy who had come to us from another school system; the other three discarded papers ranged in value from 0 to 40%. All the boys who took this test, as well as all those who took the test this year under exactly similar conditions, were graduates of Boston public grammar schools.

Following is the test given in September, 1909:

1. A baseball nine won 56 games and lost 74 games. Calculate its league standing to three places of decimals. (General directions were given for the proper solution of this problem.)

2*a* Add 3⅝, 4⅔, 6½, and 8¼.

2*b* Reduce the fractional part of this answer to a decimal, approximating to thousandths.

3. On September 1, 1909, my bank balance is $275.63. During September I draw on it checks for the following amounts: $3.37, $18.75, $62.45, $40.00, $23.23, $4.95. What is my balance October 1, 1909?

4. What is the simple interest at 6% on $375.25 for 1 yr. 3 mo. 18 d.?

5. Add the following sums horizontally and vertically, so that in the right-hand lower corner the footing of the cross-totals will check the cross-total of the footings of the vertical columns:

$137.89	$123.40	$86.45	$347.74	
342.67	341.20	12.52	696.39	
89.25	836.21	25.04	950.50	
38.25	326.95	38.75	403.95	
12.78	374.50	78.35	465.63	

About an hour and a half was allowed for this examination, and the boys had no reason to feel hurried or driven.

On No. 1, 67 failed. Only half a dozen boys were practical enough to lop off the zero of the divisor 130, and divide 5.6 by 13.

On *2a*, 35 boys failed.

On *2b*, 68 boys failed, and the erroneous answers ranged all the way from .001 to .553. An instant's forethought would have shown that $\frac{1}{24}$, being very near $\frac{1}{25}$, must be equivalent to something like .04. Scarcely anybody got the answer right—.042. The last partial dividend being 40, the quotient figure in the third decimal place should have been, not 1, but 2. Of a long list of absurd answers, the following will serve as a sample, $.34\frac{18}{23}$. This sort of answer, which is short for $\frac{34}{100} + \frac{18}{23}$ of $\frac{1}{100}$, is very bad but very common. In interest examples pupils are taught to approximate to the second decimal place. Why not teach them in like manner to approximate to the third decimal place?

On No. 3, 19 boys failed; and of these, three added the sum of the September checks to the September balance to make the October balance. The neatest way to do such an example as this is by the method of complementary or additive subtraction. Thus:

$275.63	5, 8, 13, 18, 25, and 8, 33; carry 3
3.37	12, 14, 18, 25, 28, and 8, 36; carry 3
18.75	7, 10, 12, 20, 23, and 2, 25; carry 2
62.45	4, 8, 14, 15, and 12, 27.
40.00	
23.23	
4.95	
$122.88	

One advantage of this method is that it does away with the necessity of subtraction tables, and prepares the pupil for the Italian method of division, which leaves out the partial products. This method has been taught successfully to a fourth-grade class in one progressive Boston school.

On No. 4, 27 pupils failed. The range of erroneous answers was from $2.02 to $2659.26. Most of the pupils who obtained the right answer computed the interest on $1 for the given period, and multiplied the principal by that sum.

There would result a great gain in power and in accuracy if children were taught to begin multiplying with the left-hand digit of the multiplier, instead of with the right-hand digit, and to fix

the decimal point in the first partial product, not by a rule of thumb, but by a common-sense method. Thus this example would be done as follows:

$375.25
.078
$26.2675
3.0020
$29.2695 *Ans.* $29.27

As the principal is somewhat less than $400 and the interest is somewhat les than 8%, the first partial product is somewhat less than $32.

It is, I suppose, very difficult in this country to overcome the inertia of conservatism, in the matter of teaching multiplication; but I am given to understand that in England, wherever the influence of John Perry, the eminent engineer and educator, has prevailed, this method is a commonplace of practice. It is common, too, in various parts of Germany; Frenchmen, also, have told me that it has long been in use in France.

Many eminent professors of mathematics, in colleges and in technical schools, advocate rewriting the multiplier reversing the order of the digits. This is artificial, and obviously unsound from a teacher's point of view; whereas the method of multiplication described in this paper, if taught from the very beginning, has many striking advantages, and even if introduced later it is as convenient and as efficient as the other.

As a preparation for high school work it would be of incalculable advantage, for the following reasons. Very early in the high school course the student of science and of pure mathematics must learn the essential distinction between counted quantity and measured quantity; very early he must learn that the last digit of a number obtained by measurement is always inexact, and consequently that all results obtained from data gotten by measurement are no more accurate and may be less accurate, than the least accurate of the contributing data. An area, for instance, whose dimensions are given in units and hundredths cannot be computed to four decimal places, will not be true to more than two decimal places, and may not be true even so far. This method, then, enables the high school student to avoid setting down columns of figures which make for apparent but not for real accuracy, and to economize to a surprising extent the labor of calculation.

On No. 5, 22 boys failed. This is a self-checking example;

39 boys, however, would not trust it to check itself, but rewrote some or all of the horizontal rows of figures in vertical columns before adding them up. This sort of example is very valuable for rapid work in addition. Care should be taken, however, to make them simple enough to avoid eye-strain and nerve-fatigue.

On the first school day of the next year, 160 grammar school graduates, coming from 18 public grammar school districts of Boston, were subjected by me to the following test. They were cautioned beforehand to do the work by the shortest and most economical methods known to them.

1. An estate of $18,375 was divided evenly among 10 heirs. What was the share of each?
2. A mooring stake was ½ in mud, ⅓ in water, and the rest in the air. What fractional part was in the air?
3. What is the cost of 8 yards of gingham at 37½c a yard?
4. What is the cost of 10 yards of dress goods at 62½c a yard?
5. In making the purchase mentioned in No. 4, I handed the clerk a $10 bill. What change should I receive?
6. Simplify $\dfrac{15 \times 28 \times 51}{126}$
7. Simplify $\dfrac{120 \times .125}{.875 - .125}$

The following table gives the number of boys who failed on each example, and the percentage of failure:

No. 1— 30 boys, 19%.
No. 2— 47 boys, 30%.
No. 3— 13 boys, 8%.
No. 4— 15 boys, 9%.
No. 5— 19 boys, 12%.
No. 6— 61 boys, 38%.
No. 7—133 boys, 83%.

In No. 1, 42 boys (26%) used long division. In No. 3, 125 boys (78%) followed some wasteful method, most of these multiplying 37½ by 8. In No. 4, 70 boys (44%) worked as follows:

.62½ or as follows: $\frac{5}{8} \times 10 = \frac{50}{8} = 6\frac{1}{4}$

$$\begin{array}{r} 10 \\ \hline 6.20 \\ 5 \\ \hline \$6.25 \end{array}$$

instead of as follows: $.625 \times 10 = $6.25. In No. 6, 70 boys (44%) failed to use cancellation.

Error and waste beset the work of human hands and human brains always and everywhere—not only in the elementary school, but in the high school, in the university, and beyond. These

percentages of error and of waste, however, are too high. They can be materially reduced, it seems to me, by teaching children more generally to make rough estimates beforehand, and to check up for themselves in various ways an answer once obtained. The checks for addition and subtraction are familiarly known to all teachers and need not perhaps be even mentioned. It may be well, however, to say that a complete but rarely employed check for multiplication consists in interchanging multiplier and multiplicand and performing a second multiplication whose partial products will be quite different from those of the example checked. Division of course will furnish a check for multiplication, and multiplication for division; in this last the quotient should be multiplied by the divisor, so as to get a new set of partial products.

The second test which I gave would seem to show that more drill on aliquot parts and on cancellation and factor testing would not have been amiss.

I find that many boys have a rather feeble hold on multiplication tables. The excellent experimental methods of eliciting the facts of the multiplication tables should supplement but not supplant the old-fashioned drill in memorizing.

"TENDER-HEARTED" METHODS NOT NEEDED.

Our great problem is not subject matter, but teachers. If we had good teachers we should not be hunting around for some "tender-hearted" methods of teaching science.—Superintendent M. N. McIver, Oshkosh.

SEPARATE CLASSES FOR BOYS AND GIRLS.

In our high school the girls and boys are placed in separate classes in physics and chemistry. Their work is along different lines. When the girls are studying heat, for instance, they take up the study of the fireless cooker; the boys take up such topics as determining the heat value of coal.—Superintendent G. A. Works, Menominee.

Erland Nordenskiold, in the course of an ethnographic and archæological exploration of Bolivia, in 1908 and 1909, found districts inhabited by Indians who are still living in the age of wood and stone. Because of the scarcity of stone in the Chaoc region, the natives of the banks of the Pilcomayo River do not possess even stone implements, but employ bone and hard wood as the material of knives, saws, awls, needles, and spades. The virgin and unexplored forests of the province of Sara are the home of entirely wild and uncivilized Indians, called Siriones, who have no friendly intercourse with their white neighbors. It is not even known whether they form a single tribe or a number of tribes. This part of Bolivia presents the extraordinary phenomenon of natives still living in the stone age within a few miles of places which have been inhabited by white men during several centuries. Nordenskiold obtained various implements which had been captured in primitive expeditions directed by the whites against the marauding Siriones, but he was not able to come into contact with these interesting aborigines.

PROBLEM DEPARTMENT.

By E. L. Brown,

Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott St., Denver, Colo.

Algebra.

224. *Proposed by Grace E. Shoe, Denver, Colo.*

Solve: $x^{\frac{5}{8}} + x^{\frac{3}{8}} = (2^8 + 2^{-8}) x \sqrt[8]{x^{2/3}}$ (Hawkes' Advanced Algebra, Page 79, Ex. 26.)

I. Solution by G. W. Smith, Boulder, Colo., and Newton D. Clarke, Boston, Mass.

The given equation can be written as follows:

$x^{\frac{3}{8}}(x^{\frac{5}{8}} - 2^8)(x^{\frac{5}{8}} - 2^{-8}) = 0.$

$\therefore x^{\frac{3}{8}} = 0,\ x^{\frac{5}{8}} = 2^8,\ x^{\frac{5}{8}} = 2^{-8} \qquad \therefore x = 0.$

$x^{\frac{5}{8}} = 2^8,\ \therefore x^8 = 2^{8 \cdot 15};$

$x^4 = +2^{4 \cdot 15}$ or $-2^{4 \cdot 15};$

$x^2 = +2^{2 \cdot 15}, -2^{2 \cdot 15}, +i\,2^{2 \cdot 15}, -i\,2^{2 \cdot 15}$, where $i = \sqrt{-1};$

$x = \pm 2^{15}, \pm i\,2^{15}, \pm i^{\frac{1}{2}}\,2^{15}, \pm i^{\frac{3}{2}}\,2^{15}.$

From $x^{\frac{5}{8}} = 2^{-8}$, in a similar manner we find

$x = \pm 2^{-15}, \pm i\,2^{-15}, \pm i^{\frac{1}{2}}\,2^{-15}, \pm i^{\frac{3}{2}}\,2^{-15}.$

$\therefore x = 0, \pm 2^{\pm 15}, \pm i\,2^{\pm 15}, \pm i^{\frac{1}{2}}\,2^{\pm 15}, \pm i^{\frac{3}{2}}\,2^{\pm 15}.$

II. Solution by H. E. Trefethen, Kent's Hill, Me.

$x^{\frac{15}{8}}(x^{\frac{5}{8}} + x^{-\frac{5}{8}} - 2^8 - 2^{-8}) = 0.$ Whence $x^{\frac{15}{8}} = 0$ and $x = 0$. Also $(x^{\frac{5}{8}} - 2^8) + (x^{-\frac{5}{8}} - 2^{-8}) = 0.$ This is a reciprocal equation of the 16th degree in $x^{\frac{1}{8}}$. Obviously the 16 values of x are the 8 roots of $x^{\frac{5}{8}} = 2^8$ and their reciprocals. Thus $x^{\frac{1}{8}} = +2^4, -2^4, x^{\frac{2}{8}} = +2^2, -2^2, +2^2\sqrt{-1}, -2^2\sqrt{-1}.$

$x^2 = +2^{30}, -2^{30}, -2^{30}\sqrt{-1}, +2^{30}\sqrt{-1}.$

$x = \pm 2^{15}, \pm 2^{15}\sqrt{-1}, \pm 2^{15}(\sqrt{2} - \sqrt{-2})/2, \pm 2^{15}(\sqrt{2} + \sqrt{-2})/2.$

The reciprocals are $\pm 2^{-15}, \mp 2^{-15}\sqrt{-1}, \pm 2^{-15}(\sqrt{2} + \sqrt{-2})/2,$ $\pm 2^{-15}(\sqrt{2} - \sqrt{-2})/2.$

The first eight of these results are the 8 eighth roots of $+1$ multiplied by 2^{15}. For $\sqrt{+\sqrt{-1}} = \pm(\sqrt{2} + \sqrt{-2})/2,\ \sqrt{-\sqrt{-1}} = \pm(\sqrt{2} - \sqrt{-2})/2.$

All the answers may be combined in the following forms: $0, \pm 2^{\pm 15}, \pm 2^{\pm 15}\sqrt{-1}, \pm 2^{\pm 15}(\sqrt{2} \pm \sqrt{-2})/2.$

225. *Proposed by E. L. Blackshear, Prairie View, Texas.*

Prove: Any number which is a perfect cube has a cube root which is some multiple of six, plus the remainder left after dividing the cube by six.

I. Solution by W. B. Borgers, Grand Rapids, Mich., and C. D. Donaldson, Alma, Wis.

Let $x = 6m + n$. Then $x^3 = 216m^3 + 108m^2n + 18mn^2 + n^3$.....(1) Since each term of second member of (1), except n^3, is a multiple of 6, therefore the remainder obtained in dividing this member by 6 will be the remainder obtained in dividing n^3 by 6. By problem 212 $n^3 - n = (n - 1)\ n\ (n + 1)$, which is the product of three consecutive integers is a multiple of 6. That is, the remainder obtained in dividing n^3 by 6 is n. Therefore the remainder obtained in dividing x^3 by 6 is the same as is obtained in dividing x by 6.

II. Solution by I. L. Winckler, Cleveland, O.

Any number is of the form $6m$, or $6m \pm a$, where a is 1, 2, or 3.

$(6m)^3$ is a multiple of 6 plus 0.

$(6m \pm a)^3$ is a multiple of 6 plus or minus a^3.

$a^3 = 1$, 8, or 27

$= 1$, 6 + 2, or 4·6 + 3.

$\therefore$ $(6m \pm a)^3$ is a multiple of 6 plus or minus a, where a is 1, 2, or 3.

$\therefore$ when $(6m \pm a)^3$ is divided by 6, the remainder is plus or minus 1, 2, or 3.

$\therefore$ either $6m$ or $6m \pm a$ is a multiple of 6, plus the remainder obtained in dividing $(6m)^3$ or $(6m \pm a)^3$ by 6.

III. Solution by H. E. Trefethen, Kent's Hill, Me.

Let the integers x^3, x be divided by 6, p and q the quotients, r and r' the remainders. Then $x^3 = 6p + r$, $x = 6q + r'$, $x^3 - x = 6\ (p - q) + r - r'$, $(x^3 - x)/6 = p - q + r/6 - r'/6$. By 212 $(x^3 - x)/6 =$ an integer. By hypothesis p, q, r, r' are each positive integers, r and r' being each <6. Hence it must be that $r/6 - r'/6 = 0$ and $r = r'$.

Geometry.

226. *Proposed by H. E. Trefethen, Kent's Hill, Me.*

If from any point in either side of a right triangle, a line is drawn perpendicular to the hypotenuse, the product of the segments of the hypotenuse is equal to the product of the segments of the side plus the square of the perpendicular.

I. Solution by Michael Idelson, Denver, Colo.

Let CB be the hypotenuse of the given triangle. From D, a point in AC, drop DE perpendicular to CB. Construct circle with diameter BC. Let chord through DE intersect circle in F and G. Let A and F be on same side of diameter BC.

Now $AD \cdot DC = FD \cdot DG = (FE - DE)\ (FE + DE) = FE^2 - DE^2 = BE \cdot EC - DE^2$.

II. Solution by G. I. Hopkins, Manchester, N. H., and J. H. Bortz, Greensburg, Pa.

Since the right triangles ABC and DEC are similar $CD \cdot CA = CE \cdot CB$.

or $CD^2 + CD \cdot DA = CE^2 + CE \cdot EB$

or $CE \cdot EB = CD \cdot DA + CD^2 - CE^2 = CD \cdot DA + DE^2$.

III. Solution by W. K. Given, Pomeroy, Wash., and R. H. Marshall, Bowling Green, Ky.

$BC^2 = AB^2 + AC^2$

or $BE^2 + 2BE \cdot EC + EC^2 = AB^2 + AD^2 + 2AD \cdot DC + DC^2$.... (1)

Since $AB^2 = BD^2 - AD^2$, and $BD^2 = BE^2 + DE^2$,

Then $AB^2 = BE^2 + DE^2 - AD^2$.... (2)

Also $DC^2 = DE^2 + EC^2$.... (3)

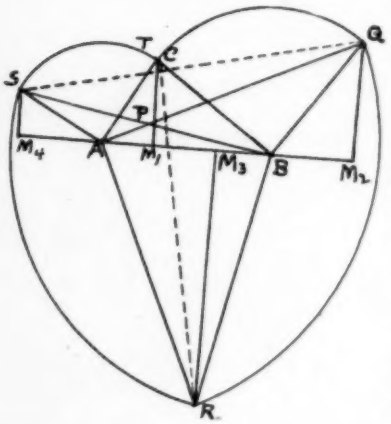
Substituting (3) and (2) in (1) and simplifying we have

$BE \cdot EC = AD \cdot DC + DE^2$.

227. *Proposed by Norman Anning, Chilliwack, B. C., Canada.*

A, B, and C are any three points in a plane. With center B a circle-quadrant CQ, with center A a quadrant QR, with center B a quadrant RS, and with center A a quadrant ST are described, all in the same direction of turning. Prove that T and C coincide.

I. Solution by Newton D. Clarke, Boston, Mass.



Drop perpendiculars from C, Q, R, S to AB, produced if necessary, letting their feet be M_1, M_2, M_3, M_4.

Since $BC = BQ$ and $\angle BQM_2 = \angle M_1BC$, triangles CM_1B and BM_2Q are equal. Similarly $\triangle AQM_2 = \triangle RAM_3$, and $\triangle RM_3B = \triangle BM_4S$.

$\therefore BM_2 = CM_1$ and $BM_4 = RM_3 = AM_2$. Subtracting AB from BM_4 and AM_2 we have $AM_4 = BM_2$. $\therefore AM_4 = CM_1$.

Also since $AM_3 = QM_2 = BM_1$, $AM_1 = BM_3$.

Now $SM_4 = BM_3$. $\therefore SM_4 = AM_1$.

Since $AM_4 = CM_1$ and $SM_4 = AM_1$, the $\triangle$s ASM_4 and ACM_1 are equal, and $AS = AC$. Also $\angle SAM_4 + \angle CAM_1 =$ rt. angle.

$\therefore \angle SAC =$ rt. angle.

$\therefore$ a quadrant described with A as a center and AS as a radius will terminate in the point C.

II. Solution by H. E. Trefethen, Kent's Hill, Me., and I. L. Winckler, Cleveland, O.

Let P be the point of intersection of AQ and BS (either or both produced if necessary) and observe that angles are positive or negative according to the direction of turning (as shown by the order of the letters) and that angles may exceed 180°, for instance QAT, QBR in some cases.

$AQ = AR$ and $AS = AT$ by construction. Also $QAS = QAT - 90° = RAT$. Hence triangles $AQS = ART$. Likewise $BC = BQ$, $BR = BS$, $RBC = SBC + 90° = SBQ$ and triangles $BRC = BSQ$.

Again $ARC = ARB - CRB$ and $AQS = APS - QSB$ (or its supplement). But $CRB = QSB$ and also $ARB = APS$ (or its supplement as the case may be), each being equal, or supplementary, to BPA. Hence angle $ARC = AQS$. Also $AR = AQ$ and $RC = QS$. Therefore triangles $ARC = AQS = ART$. AR is a common side of triangles ARC and ART. Hence C and T, lying on the same side of AR, must coincide.

III. Solution by T. M. Blakslee, Ames, Iowa.

If (a, b) and (c, d) are the rectangular coördinates of the extremities of a line segment, and this be turned about (a, b) as a center until (c, d) describes a quadrant, the terminus of the quadrant is

$$[(b+a)-d,\ (b-a)+c].$$

If A, B, C, are (a_1, b_1), (a_2, b_2), (a_3, b_3), then

Q is $(b_2+a_2-b_3,\ b_2-a_2+a_3)$,

R is $(b_1+a_1-b_2+a_2-a_3,\ b_1-a_1+b_2+a_2-b_3)$,

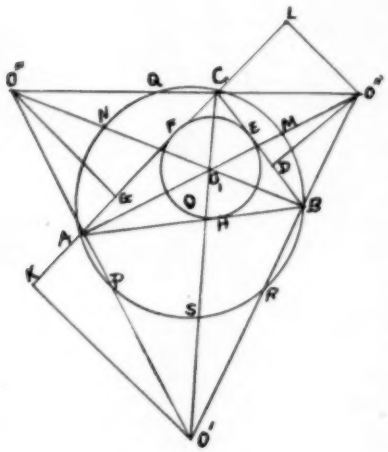
S is $(a_1-b_1+b_3,\ a_1+b_1-a_3)$, and

T is (a_3, b_3).

228. *Selected.*

Prove that the circumcircle of a triangle bisects each of the six segments determined by the in-center and the three ex-centers of the triangle.

I. Solution by I. L. Winckler, Cleveland, O.



Let ABC be the triangle; O the center of its circumcircle; O_1 the center of its incircle tangent to BC at E, AC at F, and AB at H; O' O'', and O''' the centers of its escribed circles; circle with center O' tangent to AC, produced, at K; circle with center O'' tangent to BC and AC produced, at D and L, respectively; circle with center O''' tangent to AC at G.

Since O_1 O'' bisects angle A it bisects arc BC of the circumcircle. Also the radius of the circumcircle perpendicular to BC bisects arc BC. Call this point M.

Now BE = CD. For BE = $s - b$, and CD = $s - b$. ∴OM bisects ED and since O_1E, OM, and O''D are parallel, OM bisects O_1O'' also ∴ the circumcircle bisects O_1O''. Similarly it may be shown that it bisects O_1O' and O_1 O'''.

Again, let the circumcircle intersect O'O'' at R. Now O_1B bisects angle B and ∴ O_1B, produced, bisects arc AC. Let the middle point of arc AC be N. Also O_1B is perpendicular to O'O'' which bisects the supplementary adjacent angle of angle B. ∴ angle RBN is a right angle and ∴ RN is a diameter perpendicular to AC. AK =CL, each being equal to $s - b$.

∴ since RN bisects AC, RN bisects KL and ∴ O'O''. Similarly it may be shown that the circumcircle bisects O'O''' and O''O'''.

II. Solution by H. E. Trefethen, Kent's Hill, Me.

Let O_1 be the in-center, O'', O''', O' the ex-centers of the triangle ABC, A on O'''O', B on O'O'', C on O''O'''.

(1). To prove that M, N, S, the mid-points of O_1O'', O_1O''', O_1O' in order, are on the circle ABC. O_1BO'', O_1CO'' are right angles, for the sides of each bisect two pairs of vertical angles. Hence MB = MC and M is on the perpendicular bisector of BC. But M is on the bisector of angle BAC. Therefore M is the mid-point of arc BC. Likewise N, S, are on the circumcircle. (2) Let the circle ABC cut O'O''', O'O'', O''O''' also at the points P, R, Q in order.

To prove that PO''' = PO'. MAP is a right angle. Hence MP is a diameter of the circumcircle and thus MNP is a right angle. But MN is parallel to O''O'''. Hence NP is parallel to O_1O' and P is the mid-point of O'O'''. Likewise R and Q are mid-points on O'O'', O''O'''.

Remark. The circle through A, B, C; M, N, S; P, Q, R is called the nine points circle of the triangle O'O''O'''. Its discovery is usually referred to L. Euler (1707-1783).

The same circle is also the nine points circle of the three triangles O_1O''O''', O_1O'''O', O_1O'O'', since it passes through the mid-points of the sides of each.

CREDITS FOR SOLUTIONS RECEIVED.

Algebra 218. A. W. Rich. (1)
Geometry 219. T. E. Peters. (1)
Algebra 221. Edla G. Berger, T. J. Fitzpatrick, C. Mosgrove, E. E. Watson. (4)
Trigonometry 223. J. H. Bortz, A. W. Rich. (2)
Algebra 224. Mary A. Barkley, W. L. Baughman, P. S. Berg, Edla G. Berger, T. M. Blakslee, W. B. Borgers, O. L. Brodrick, Newton D. Clarke, G. I. Hopkins, H. L. McAlister, A. L. McCarty, Glendora Mills, C. A. Perrigo, Kate Schweibold, Guy W. Smith, H. E. Trefethen, Isadore S. Van Gilder, James A. Whitted, one from Fairfield, Ia. (19)
Algebra 225. T. M. Blakslee, W. B. Borgers, N. D. Clarke, C. D. Donaldson, H. E. Trefethen, I. L. Winckler, one from Fairfield, Ia. (7)
Geometry 226. P. S. Berg, Edla G. Berger, T. M. Blakslee, W. B. Borgers, J. H. Bortz, O. L. Brodrick, A. B. Carlton, N. D. Clarke, C. D. Donaldson, W. K. Given, G. I. Hopkins, M. Idelson, R. E. Krug, Mary Lois (2 solutions), R. H. Marshall, H. L. McAlister, A. L. McCarty, O. E. McDowell, Edward Morgan, C. A. Perrigo, H. A. Porter, Kate Schweibold, O. R. Sheldon, E. D. Shelton, J. M. Townsend, H. E. Trefethen, J. A. Whitted, I. L. Winckler, L. O. Worley, one from Fairfield, Ia. (31)
Geometry 227. T. M. Blakslee, N. D. Clarke, H. E. Trefethen, I. L. Winckler. (4)
Geometry 228. N. D. Clarke, H. E. Trefethen, I. L. Winckler. (3)
Total number of solutions, 72.

PROBLEMS FOR SOLUTION.

Algebra.

234. *Proposed by E. B. Escott, Ann Arbor, Mich.*

Solve $xy + zu = 17$ (1)
$yz + ux = 11$ (2)
$xz + yu = 13$ (3)
$x + y + z + u = 11$ (4)

(Rietz and Crathorne's College Algebra, p. 79, ex. 31.)

235. *Proposed by H. C. Fetsch, Cincinnati, O.*

Sum to n terms the series,

1, 1, 2, 3, 5, 8, 13, 21, 34, etc.

Geometry.

236 *Proposed by A. Heinz, Savannah, Mo.*

Prove that the bisectors of the vertex angles of all triangles on the same side of a common base meet in a point when, *and only when*, these vertex angles are equal.

237. *Proposed by R. F. Holden, Kalamazoo, Mich.*

Find the locus of all points from which two unequal circles subtend equal angles.

238. *Proposed by Mary S. Sabin, Denver, Colo.*

An approximate construction of a regular polygon of n sides is as follows: Divide the diameter AB into n equal parts, $AA_1 = A_1A_2 = A_2A_3 = \ldots\ldots = 2\,R \div n$. With A and B as centers and AB as a radius describe arcs

intersecting in C. Produce the line segment CB_2 to intersect the circle in D. Then will AD be approximately a side of the regular polygon. Find the actual value of AD expressed by R and n, and show in which polygon or polygons the above construction is absolutely correct.

AN OBNOXIOUS BILL.

Nearly all people in this country are aware of the fact that when stamped envelopes are purchased from the government, in lots of 500 or more, that the return address of the person will be printed on the upper left-hand corner without extra cost. This is one of the channels through which our government is directly benefiting the people.

There is practically no extra expense to the government attached to this printing. It is a great accommodation and big saving to thousands of users of the mails.

There is now pending in Congress a bill which is intended to prevent the government from serving the people in this manner. It originated with a few narrow-minded printers who seemed possessed with the idea that they should be given this work. Congressman Lou Velle of Ohio was persuaded to introduce and father the bill. This piece of proposed legislation should be killed and put out of existence without any quibbling. Persons reading this are earnestly requested to write their congressman asking him to use his influence against the measure.

COAL MINING IN MARYLAND IN 1909.

The decreased production of coal in Maryland during the last two years appears to have been due to the approaching exhaustion of the "Maryland big vein," the portion of the Pittsburg bed that has furnished the larger part of the Maryland output, which is popularly known as Georges Creek coal. In a few years the thinner and deeper beds will be furnishing the markets formerly supplied by the "big vein" coal, but these beds will be mined at a greater cost and their product must be sold at a higher price or at less profit. In the aggregate, however, the quantity of coal that may be won from these thinner beds far exceeds the original contents of the celebrated "big vein." Increased competition with West Virginia coal, particularly that coming from the fields opened up by the new Virginian Railway, is regarded as the chief cause of the decline in the price of Maryland coal in 1908 and 1909.

In 1909, as in 1908, thirty-nine mining machines were owned by the coal mining companies of Maryland, but not all of these machines were in use. The machine-mined coal decreased from 208,134 short tons in 1908 to 117,568 tons, or 2.9 per cent of the total production, in 1909. None of the Maryland coal is washed.

Montana's notable increase in coal production in 1909 was due principally to the revival of the metal-mining industry and to bountiful crops, which brought generally prosperous conditions throughout the state. Mining operations were not interfered with by strikes, suspensions, or lockouts, the only labor disaffection being one strike of ten days' duration, and although there was some shortage of cars among the fruit and grain shippers, the coal mines seemed to have a sufficient supply for their needs.

SCIENCE QUESTIONS.

By Franklin T. Jones,

University School, Cleveland, Ohio.

Our readers are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.

Questions and Problems for Solution.

36. *Proposed by John C. Packard, Brookline, Mass.*

Wooden sphere, specific gravity 0.7. To what depth will it sink in salt water, specific gravity 1.026?

The following entrance examination paper in physics was set by Columbia University in 1908. Please send answers to the specially numbered questions.

Note.—Time: Two hours.

37. (1) A boy throws a ball vertically upward, and four seconds later it strikes the earth. What height did the ball attain, and with what velocity did it leave the boy's hand?

38. (2) A dog hitched to a cart can exert a pull of 10 Kg. With what velocity must the dog move in order to do work at the rate of twenty kilogrammeters per second? Name and define the c.g.s. units of force, work, and power.

39. (3) A twenty-gram weight attached to one end of a uniform rod 100 cm. long causes it to balance about a point 20 centimeters from that end. Find the weight of the rod.

(4) A string has its two ends attached to points 100 cm. apart in a horizontal plane. At the middle point of the string is attached a weight of 5 Kg., and the point is twenty centimeters below the horizontal plane. Find, by graphical solution, the tension on the string. Suggestion—Let the distance between the lines of the examination book represent 10 cm. and 1 Kg. respectively.

(5) What is the atmospheric pressure in grams per square centimeter when the barometer stands at 76 cm.? Density of mercury equals 13.6 gr./cm^2.

40. (6) A rectangular block of stone, 20x30x40 cm., has a density of 2.0 gr./cm.^{3} What force will be required to lift this block under water?

41. (7) What must be the length of an open organ pipe that will give a fundamental note of 200 vibrations per second, if the velocity of sound in air is 300 meters per second?

42. (8) A piece of copper weighing 200 grams is taken from an oven and placed in 500 cubic centimeters of water. The temperature of the water is changed from 20° C. to 30° C. If the specific heat of the copper is 0.69, what was the temperature of the oven?

(9) Draw optical diagrams showing the path of the rays in the formation of a real image by a double convex lens, and of a virtual image by a double concave lens.

(10) Draw a diagram showing the path of the rays in the formation of a spectrum by a prism, and indicate the position of the colors.

(11) Draw a diagram of the parts and connections of an electric door-bell.

(12) Draw a diagram showing the principal parts and connections of a simple type of dynamo.

SOLUTIONS.

34. *Proposed by Chas. H. Korns, Bradford, Pa.*

Two floors are 27 feet apart. A man weighing 200 pounds ascends from the lower to the upper; (*a*) by a flight of stairs, each step one foot high and one foot deep, walking at a uniform speed; (*b*) by the same flight of stairs with a uniform acceleration of three feet per second per second both vertical and horizontal; (*c*) by the same flight of stairs, starting at rest and having a uniform acceleration of three feet per second per second both horizontal and vertical for two seconds, when the speed becomes uniform at the rate attained; (*d*) by a vertical ladder at uniform speed; (*e*) by the same ladder with a uniform acceleration of three feet per second, having started at rest. What is the work done in each case?

It is assumed that the question is how much work is done in lifting a 200 pound weight through a vertical distance of twenty-seven feet, the weight passing over different paths from C to A and from B to A. It is assumed that friction is disregarded.

Solution by C. D. Donaldson, Alma, Wis.

Let us suppose the weight is at A. The work done in raising the weight from any point on the lower floor to A on the upper floor is equal to the energy accumulated by the weight in falling 27 feet under the influence of gravity. Otherwise one could create energy. The energy accumulated by the body in falling vertically from A to B is equal to $\frac{1}{2}mv^2$. Kinetic energy $= \frac{1}{2}mv^2$; m is the mass and v is the velocity per second.

$S=\frac{1}{2}gt^2$. $S=27$; g=gravity acceleration; t=time in seconds.

$27=\frac{1}{2}(32.15)t^2$. Whence $t=\sqrt{\frac{54}{32.15}}$

$v=gt$. $v=32.15\sqrt{\frac{54}{32.15}}$

K. E.$=\frac{1}{2}mv^2$; K. E.$=\frac{1}{2}(200)\left[32.15\sqrt{\frac{54}{32.15}}\right]^2=$

$100\times32.15\times54$=the number of foot-poundals, or absolute units of work done. Dividing by g: $\frac{100\times32.15\times54}{32.15}=5400$. The number of foot-pounds of work done in each case when friction is disregarded.

But work $=$ FS $=$ 200x27 $=$ 5400. The number of foot pounds of work in raising a weight of 200 pounds from the lower to the upper floor, no matter how devious the path, nor how much the speed varies, nor how much time is taken. Otherwise energy would be created, i. e., the body at A would have a varying amount of potential energy depending upon the manner of its having reached A from the lower floor. But all the energy it has is represented by the amount it will accumulate in falling from A to B, which is 5,400 foot pounds.

Solution by Wm. B. Borgers, Grand Rapids, Mich.

(*a*) $W = Fs = 200\times27 = 5{,}400$ ft. lb.

(*b*) $F = ma = 200\cdot3\sqrt{2}$ poundals (against inertia).

$W = Fs = 200\cdot3\sqrt{2}\cdot27\sqrt{2} = 32{,}400$ ft. poundals $= 1{,}012.5$ ft. lb.

Adding the 5,400 ft. lb. work done against gravity, the total work is 6,412.5 ft. lb.

(*c*) $s = \frac{1}{2}at^2 = 6\sqrt{2}$. Work done against inertia is $W = Fs = 600\sqrt{2}$ $6\sqrt{2}\div32 = 225$ ft. lb. Total work $5{,}400 + 225 = 5{,}625$ ft. lb.

(*d*) $200\times27 = 5{,}400$ ft. lb.

(*e*) $F = ma = 600$ poundals $= 18.75$ lb. against inertia. Total force is 218.75 lb. $W = Fs = 218.75 \times 27 = 5{,}906.25$ ft. lb.

35. *Proposed by Chas. H. Korns, Bradford, Pa.*

Why is the shell of a boiled egg more easily removed after submerged in cold water?

Solution by Wm. B. Borgers, Grand Rapids, Mich.

There are two or three answers:

(1) Because the interior has a higher coefficient of heat expansion than the shell, and so contracts away from the shell. (A physicist's answer.)

(2) Because it does not burn your fingers. (Practical man's answer.)

(3) Is it true? (A Missourian's answer.)

"DETESTED SCIENCE" IN THE HIGH SCHOOL.

A REPLY TO PERCY E. ROWELL.

Mr. Percy E. Rowell, in an article in the November number of SCHOOL SCIENCE AND MATHEMATICS, makes certain statements which it seems should hardly pass unchallenged. I must confess I was rather amazed when I read his impassioned query: "Why is the study of science so detested in the high school?"

Some of us who have been at least going through the motions of teaching science for many years feel rather abashed that we had not discovered this too. But, speaking for myself, I may say that in the high schools with which I have been connected the students have shown their detestation of science in a strange way. At the beginning of each new semester classes have been overcrowded till in one school the science teachers have increased in six years from two to six, while the total school enrollment increased but seventy-five per cent during the same time.

Mr. Rowell answers his own query by saying, "It is because it is divided into sections many of which do not, and never will, touch the lives of the pupils." This answer would have been more satisfactory had he entered into particulars and given us the names of those sections which never will touch the lives of the pupils. It is true that in some schools, under the blighting influence of certain universities, physics has been taught as a branch of mathematics so that students have been utterly ignorant of the vast importance of its fundamental principles and their applications in the industries, but this deplorable condition is passing away and certainly is not true of chemistry, botany, zoölogy, and physiology, which touch the everyday activities of home and community life at a thousand points.

It seems to me that if subjects are detested, or fail to touch the lives of the pupils, it is the fault of the teacher and his presentation of the subject, and not because of any lack in the science itself.

As proof of my position I may only say that I have seen high school classes of students in physiology, zoölogy, botany, and chemistry eagerly clamor for a second year in the science in which they had just completed a year's work. And in every instance they did so because the subject supplied some real need, satisfied their intellectual and moral desires, and especially because it was of direct use to them in the common duties of life.

ALBERT C. HERRE, PH.D.,
Vice-Principal Fremont High School, Oakland, Cal.

AUSTRALIA AND THE METRIC SYSTEM.

[Department of Metrology]

Australia is a country of about the same area as the United States, but is far in the lead of us in ideas concerning weights and measures. This is due in part to the fact of her being behind us in coinage notions, and in part because the metric system is taught in all the public schools. She also uses a system of money which is not in harmony with many other countries with which she trades, except the mother country. Thus she has the foresight to see that her trade is thereby greatly restricted in two ways, money measurements on the one side and the measurement of commodities on the other. She is seeking to correct both weight and coinage at the same time, and she is impressed with the idea that a change in one is as necessary as in the other, and only needs legislation.

At a meeting of the House of Representatives of the commonwealth of Australia August 4, 1910, after elaborate debate, it was voted, thirty-five to two, to urge the English Parliament to pass a bill in favor of metric reform of weights and measures, and decimal coinage. Instead of passing the law direct, she preferred to have the government of the mother country take the initiative. At the same time it was discussed and strongly intimated that if England did not make a move the Australian government would. Among other reasons brought forward was the fact that their commonwealth was hampered by having to do much business with metric countries much nearer neighbors than the mother country. The vote—thirty-five to two—was very indicative of keen business insight and determination to go ahead themselves irrespective of England. This, we believe, will bring the real question before the British Parliament more forcibly than ever before, and for one thing because the rising generation has for years been taught the metric system in all the public schools, different from what has taken place in a great majority of the lower grades in the United States.

The following are the four resolutions passed by a vote of 35 to 2:

1. That in the opinion of this House it is desirable that the metric system of weights and measures should be adopted, with the least possible delay, for use within the Empire.

2. That the most convenient method of obtaining the object stated in resolution 1 is the passage of a law by the imperial Parliament rendering the use of the metric system compulsory for the United Kingdom, and for all parts of the Empire whose Legislatures have expressed, or may hereafter express, their willingness to adopt that system.

3. That these resolutions be communicated by address to his excellency, the governor general, for transmission to the secretary of state, for the colonies.

4. That the foregoing resolutions be forwarded to the Senate, by message with a request for its concurrence thereon.

That motion was agreed to by both Houses.

Mr. G. B. Edwards, who introduced the bill and made the chief argument in its favor, said among other things:

"I appeal to the supporters of the government who constitute a majority of this House in sending through the ministry this request to the imperial conference, with such an expression that statesmen at home will be under no misapprehension as to what we in Australia want. If England does not see her way clear, or is too fully occupied with other political questions, to give the necessary consideration to this great reform, let Australia, in the terms of the motion, take up the reform for herself." Everybody must regard this as a great victory for the metric cause. ED. METR.

REPORT OF THE MEETING OF THE ASSOCIATION OF MATHEMATICAL TEACHERS IN NEW ENGLAND.

The eighth annual meeting of the Association of Mathematical Teachers of New England was held at the Mechanic Arts High School, Boston, on Saturday, December 3, at 2 P. M.

The president, Mr. Charles A. Hobbs of Watertown, Mass., presided and the following business was transacted: Mr. Wm. B. Carpenter, chairman of the Committee on Nominations, reported the following list of nominations: for president, Mr. Archibald V. Galbraith of the Middlesex School, Concord, Mass.; for vice-president, Prof. Geo. D. Olds, Amherst College, Amherst, Mass.; for secretary, Mr. Harry D. Gaylord, Harvard University, Cambridge, Mass.; for treasurer, Mr. Frank P. Morse, Revere High School, Revere, Mass.; for members of the council, Miss Bertha Carrol, Boston, Mass.; Prof. Julien L. Coolidge, Harvard University, Cambridge, Mass.

One ballot was cast by the secretary for the election of the above list of officers and the remainder of the afternoon was taken up with two papers—the first, "Efficiency in Calculation," by Professor J. C. Tracy of Yale University; and the second, "Two Experiments On Grammar School Graduates," by Peter F. Gartland of the English High School, Boston, which appear on page 155 of this Journal.

After a discussion of these papers, the members of the Association were invited to inspect the buildings and equipment of the Mechanic Arts High School.

EFFICIENCY IN CALCULATION.

The following is an abstract of Prof. Tracy's paper: Efficiency may be expressed by the following formula:

$$\text{Efficiency} = \frac{\text{Amount of useful work done}}{\text{Energy expended}} = \frac{\text{Accuracy and correctness}}{\text{Time and effort}}$$

in which accuracy = done with care, and correctness = done according to accepted rules.

Accuracy is not obtained merely by exercising care. The checking of calculations is recognized in practice as much a part of the work as are the original calculations. In order to establish this habit of checking the student should be required to check his own work and that of others.

Some of the more important methods of checking can be classified as follows: (1) Checking arithmetical work, multiplication, and division, by "casting out nines" and "casting out elevens." (2) Checking results by known conditions; for example, the three interior angles of a plane triangle = 180°.

(3) By using different methods of computation; as the sides of a right triangle obtained by trigonometry and checked by geometry.

(4) By using different data; as in the computing of the diagonal of a quadrilateral, first from one triangle and then from another.

(5) Graphical and mechanical checks.

(6) Approximate checks by use of common sense.

Correctness depends upon method and is discussed under the heading, "Elimination of Useless Refinement."

Time and Mental Effort are reduced by means which are classified below:

(1) By adopting economic methods of procedure. Blocking out the work before calculations are begun, and then grouping like operations. In this way the effort may be concentrated upon one thing at a time, and the mind relieved from strain. Much of the work thus becomes mechanical.

(2) By systematic arrangement of work.

(3) By using short cuts, such as using, in place of the multiplier, its factors ($42\times27 = 42\times9\times3$).

(4) By eliminating worthless refinements.

(5) By using in addition to the usual tables, special tables, such as 3.1416 multiplied by each digit from 1 to 9.

(6) By use of graphic diagrams which give good approximations for some kinds of work.

(7) By using mechanical devices such as planimeter and slide rule.

In logarithmic computation choice should be made between the functions on account of the following facts.

(a) An angle is best determined from a function which changes rapidly, i. e., with large tabular difference.

(b) A quantity to be found from a given angle is best determined by means of a function which changes slowly. (c) Tangents and cotangents vary more rapidly than sines and cosines—hence use the former to determine angles and the latter to determine lengths.

Abridged multiplication and division can be used to advantage when approximate results are required or when the data is given only to a few significant figures. The following is a rule for such work:

Abridged Multiplication—If a result is required to n places of figures write the first or right-hand figure of the reversed multiplier under the $n+1$th place of the multiplicand. (If from inspection it is seen that the product of the first left-hand figure of the multiplicand by the first right-hand digit of the reversed multiplier exceeds nine (allowing for anything carried over) it is sufficient to place the first digit of the reversed multiplier under the nth place of the multiplicand.)

Eliminating Worthless Refinements. (1) Numbers expressing measurements cannot be exact. Last digit in measurement always uncertain. (2) A result cannot be ore accurate than the least accurate of the data from which it is obtained. (3) *Consistent* accuracy, not *absolute* accuracy the aim. Consistent accuracy independent of the number of *decimal* places. 3216 ft., 321.6 ft., 32.16 ft., 3.216 ft., all of relative accuracy of 5/32160 or 1/6432. (4) Accuracy that can be obtained is determined by number of certain figures in data, hence some approximate expression of accuracy of a measurement must be known. 7,200 ft. may contain one, two, or three certain figures. Greatest number of certain figures ever attained is seven, by Michelson in determination of meter in terms of wave length of a certain spectral line. (5) In addition or subtraction result cannot be accurate beyond first doubtful place in any number added or subtracted. (6) In multiplication the number of certain figures in the product can never exceed by more than one of the number of certain figures in that factor having the smaller number of certain figures.

Rules for Multiplication—(1) Ascertain from inspection which of the two factors contains the smaller number of certain figures. Call this the limiting factor. (2) Use the abridged method of multiplication. Reverse the limiting factor for a multiplier, count off from left to right one more place in the multiplicand than there are certain places in the multiplier, and begin under this place to write the multiplier backward from right to left. *Note*—This method gives the result exactly to one uncertain place, and the error in the second uncertain place, if there is any, will rarely exceed one unit. (See rule for "Abridged Multiplication.")

Rules for Division—Use the abridged method, and determine by inspection the number of figures rendered uncertain in the result by the number of uncertain figures in the divisor, i. e., the limiting factor.

HARRY D. GAYLORD, *Secretary.*

MINUTES OF THE EARTH SCIENCE SECTION OF THE C. A. S. AND M. T., CLEVELAND, 1910, MEETING.

The tenth annual meeting of the earth science section of the Central Association of Science and Mathematics Teachers was held in Room 107, Technical High School, Cleveland, Ohio, November 25 and 26, 1910.

The meeting was called to order at 2 P. M., November 25, 1910, by the chairman, Mr. W. M. Gregory of the Normal Training School, Cleveland, Ohio.

The chairman appointed the following committees:

Nominations, Mr. W. P. Holt, Central High School, Toledo, Ohio; Mr. C. F. Knirk, Technical High School, Cleveland, Ohio; Mr. G. A. Barker, Normal School, Normal, Ill.

Resolutions, Mr. W. C. Durstine, Technical High School, Cleveland, Ohio; Mr. E. E. Rayman, Lincoln High School, Cleveland, Ohio; Miss Charlotte Bushnell, South High School, Cleveland, Ohio.

The following papers were presented: "A High School Museum for Geography," by George A. Barker, Normal School, Normal, Ill.

"Industrial Geography, Its Meaning, Scope, and Content," by Carl F. Knirk, Technical School, Cleveland, Ohio. Abstract on Page 114.

Discussion: In response to a question Mr. Knirk stated that the course ran throughout the first year. It was planned primarily for boys, but in planning a course for girls he would introduce more of the textiles and omit some of the matter relating to iron and steel and similar industries.

Miss Grace Ellis spoke of the influence of the soil upon the occupations and habits of people and illustrated her remarks by a brief account of the border region of the driftless area in Wisconsin.

In response to a question of the advisability of introducing industrial geography into the grades, Miss Meta Wolff gave her experience with such work in the Cleveland Industrial School. She found the use of exhibits and the study of local industries helpful.

Report of the Committee on Fundamentals by W. E. Durstine, chairman, Technical High School, Cleveland, O. It was moved and carried that the report be accepted as a report of progress and that the committee be continued and added to as necessary.

"Physical Geography vs. Biology for First Year in the High School," by Miss Stella S. Wilson, School of Commerce, Columbus, Ohio. A second paper continuing the same subject by W. P. Holt, Central High School, Toledo, Ohio.

Discussion of both papers: Mr. Eikenberry expressed the opinion that biology was not too difficult for first year pupils, though his preference was for a later year. He would not advocate the use of a compound microscope in first year classes nor the use of many technical terms. He called special attention to the fact that we have no available basis of measurement for the growth of the child in consequence of the study of physical geography or biology.

The meeting of the second session, November 26, was called to order at 10 A. M. by the chairman, W. M. Gregory.

The committee on nominations reported the following list of officers for the ensuing year:

Chairman, D. C. Ridgeley, Illinois State Normal School.

Vice-Chairman, G. R. Mansfield, Northwestern University, Evanston, Ill.

Secretary, Miss Grace F. Ellis, Grand Rapids, Michigan.

These persons were duly elected.

The committee on resolutions presented the following, which was adopted:

WHEREAS, Modern geography has come to rank with the most important studies in the high school as a valuable life preparation, touching as it does the relation of man to his physical surroundings; and

WHEREAS, Too little time and attention is given to this vital and very important study;

Be it Resolved, That we strongly urge that one year be considered the minimum amount of time that can be reasonably assigned to this subject in the high school.

Be it Resolved, That this section extend its appreciation of the admirable papers presented by Mr. G. A. Barker, Miss Stella Wilson, Mr. Frank Carney, Mr. C. F. Knirk, Mr. H. P. Holt, Miss Grace F. Ellis, Mr. James H. Smith, and Prof. G. D. Hubbard.

Be it Resolved, That the thanks of the Association be extended to the American Geographical Society for the loan of the most excellent collection of maps and books. We have found them suggestive of what maps ought to be and geography in our schools will be placed on a more efficient basis when such maps are available in our school rooms.

Resolved, That it is the sense of this section that the assignment of teachers to teach geography and physiography, who are not qualified by training in these sciences, is detrimental to the interests of the sciences, of the pupils, and of the school.

It was moved by Mr. W. P. Holt that a committee be appointed to investigate and to report at the next meeting upon the desirability of a general science course in connection with the first year course in earth science in the high school. The motion was carried.

The following papers were presented:

"The Value of the Physical versus the Human Element in Secondary School Geography," by Prof. Frank Carney, Dennison University, Granville, Ohio.

The discussion was opened in brief papers by Miss Grace F. Ellis and Prof. G. D. Hubbard and then became general.

Mr. Barker of Normal, Ill., pointed out the difficulty of tracing geographic influences upon human life in cases where other elements are introduced, such as railroad rates and immigration from different regions.

Mr. James H. Smith (of Chicago) raised the question as to the source of materials and stated that he was trying to establish a course in which the work would be partly in three or four outside books, partly in text-books, and partly in laboratory work.

The report of the special committee to investigate the value of the different methods of teaching physiography, by J. H. Smith, chairman, Austin High School, Chicago, Ill. It was moved and carried that the report be received and the committee continued.

On account of the lateness of the hour Prof. Hubbard suggested that his paper on the special collection of European maps and atlases, loaned for the meeting by the American Geographical Society, be omitted. Upon request he kindly consented to speak informally on the subject after the close of the session.

G. R. MANSFIELD, Secretary.

W. M. GREGORY, Chairman.

REPORT OF THE MEETING OF THE CHEMISTRY SECTION C. A. S. AND M. T., CLEVELAND, OHIO, NOVEMBER 25, 1910.

Meeting called to order by Dr. Albert L. Smith, chairman. The secretary being absent, the chair appointed Mr. L. B. Altaffer secretary pro tem. A

motion prevailed for the chairman to appoint a nominating committee; the committee, consisting of Mr. Greenmeyer, Miss Caplin, and Mr. Lohr, then retired to consider the selection of officers, with the following result:

Chairman, Frank B. Wade, Shortridge High School, Indianapolis, Ind.

Vice-Chairman, Howard W. Adams, State Normal School, Normal, Ill.

Secretary, Lillian Kurtz, Medill High School, Chicago, Ill.

The regular program was then carried out, consisting of the following excellent papers:

"How I Attempt to Convey to High School Juniors the Meaning of a Chemical Formula," Frank B. Wade, Shortridge High School, Indianapolis, Ind.

"Physical Chemistry—A Basis for Secondary School Chemistry?" Vergil C. Lohr, Joliet Township High School, Joliet, Ill.

"An Outline of the Manufacture of Iron and Steel," B. D. Quarrie, Asst. Gen. Supt., Newburgh Steel Works and Blast Furnaces.

"The Manufacture of Paints and Pigments," Edward C. Holton, Chief Chemist for the Sherwin-Williams Company.

After questions and discussion of these papers the section adjourned.

L. B. ALTAFFER, Secretary pro tem.

PACIFIC COAST ASSOCIATION OF CHEMISTRY AND PHYSICS TEACHERS.

Meeting of this association was held in connection with the state teachers' association at Berkeley during the holiday vacation. Room 217 in the Chemistry Building was placed at the disposal of the association on Wednesday, December 28. The program was somewhat unique. The morning session was given up to the discussion of questions, "What did I Get Out of High School Science? How Might Its Value Have Been Increased?" The discussion was participated in by Dr. Daniel Crosby, Oakland, a physician; Alfred C. Skaife, San Francisco, a lawyer; Rev. A. W. Palmer of Plymouth Congregational Church, Oakland; Ward Easterly, of Easterly Construction Company, Berkeley; Perry Tompkins, manager Mason-McDuffie Company, Berkeley; and by Lewis B. Avery, principal San Jose High School. Each speaker spoke of the effect of high school science on observation and on habits of thought, but emphasized as above everything else the benefit derived from close personal contact with the teachers of science. The chief criticism of the subject arose from insufficient apparatus, a criticism that still holds good, they feel. In the afternoon Dr. H. C. Biddle gave a splendid lecture on "Liquid Air," showing many experiments which can be carried out with this material. The entire meeting was very helpful and interesting to everyone in attendance. H. F. SHELDON, Secretary.

THE ACETYLENE PROCESS.

The manufacture of acetylene gas, C_2H_2, which is accomplished by the user himself in a generator, is of important use in the attainment of high temperatures. Mixed with oxygen and ignited, it gives what is known as an oxy-acetylene flame, from which temperatures as high as 6,000 degrees F. are secured. This is especially desirable in welding processes. The extensive use of acetylene is made possible by the manufacture of calcium carbide, CaC_2, which is accomplished in the electric furnace by the action of carbon upon lime at a very high temperature. The application of water to the carbide produces a decomposition of which acetylene is one of the products. Thus three very common materials, carbon, lime, and water, are by two reactions capable of producing a very important artificial gas.

CARRARA MARBLE.

By Nicholas Knight,

Cornell College, Mount Vernon, Iowa.

While in Pisa a few months ago, we secured at a sculptor's studio a small piece of carrara marble. The specimen possessed the well-known characteristics of the variety, pure snowy whiteness, and of a fine granular crystalline structure. As we have not in the literature observed an analysis of this variety of marble, we give the results as obtained by C. E. Gillette, B.S., assistant in the chemical department of Cornell College:

$CaCO_3$	98.39 %
$MgCO_3$	1.18 %
SiO_2	0.38 %
Fe_2O_3	0.006%
	99.956%

It is thus seen that the rock is almost entirely calcium carbonate, with small amounts of magnesium carbonate, sand, and a trace of iron. The chemical composition explains the snowy whiteness of the specimen.

NOTE TAKING.

At a meeting of the chemistry and physics teachers held during the high school conference of the University of Illinois on November 18, 1910, the question of note taking came up informally for discussion. Both university and high school teachers expressed themselves as being of the opinion that too much time is devoted to the merely English part of writing up notes—time that could be more profitably spent on the science itself. The outcome of the discussion was the unanimous adoption of a resolution to the following effect: Only one out of every three of the experiments performed should be written up in full; the statement of the instructor as to the experiments not written up should suffice for college entrance credit.

SCIENTIFIC STUDY OF EDUCATION IN BIOLOGY—BIBLIOGRAPHY.

Under this caption there will be published from time to time a list of books and papers believed to be of interest to those interested in the subject. This is done as a part of the work of the committee appointed by the Biology Section of the Central Association for the purpose of encouraging research in the pedagogy of biology.

It is the intention to print the titles with a few words descriptive of each in such form that the whole of each reference may be cut out and pasted upon a standard 3x5 inch card for card catalog purposes.

Three classes of titles will be included as follows: (1) text-books and other works of general interest, but bearing upon the subject, (2) investigations the subject matter of which is not biological but which are of interest to biologists because the method may be applicable in biology and, (3) investigations in the pedagogy of biology. It is hoped to make the third division complete; in the other two only the most important titles can be included.

It is hoped that members of the section, authors of papers and publishers will coöperate by calling to the attention of the committee such papers as might not otherwise be noted.

Thorndike, Edward L.
Educational Psychology. 2nd ed. Pp. ii+248. New York: Teacher's College, 1910.
"Attempts to apply to a number of educational problems the methods of exact science." An authoritative general text-book.

Thorndike, Edward L.
Introduction to the Theory of Mental and Social Measurements. Pp. 212. New York: Science Press, 1904.
An authority in its field.

Swift, Edgar J.
Mind in the Making. Pp. viii+329. New York: Scribner, 1909.
A text-book of educational psychology. Chapters VI, VIII, and IX seem to be of most interest in connection with the scientific study of education.

Whipple, Guy M.
Manual of Mental and Physical Tests. Pp. xix+534. Baltimore: Warwick & York, 1910.
A source of information regarding the details of a multitude of educational tests. Some workers disagree with his estimate of the value of certain tests.

Ayres, Leonard P.
Laggards in Our Schools. Pp. xv+236. New York: Charities Publishing Company, 1909.
An extensive study of retardation and elimination, made with the co-operation of the Russell Sage Foundation. Ought to be known to every teacher.

Dearborn, Walter F.
Qualitative Elimination from School. Element. School Teach. *10*:1-13, fig. 1-9. Sept., 1909.
Shows by statistical investigation of records of two cities that elimination of pupils in grade and high schools removes good pupils as well as inferior ones. Pupils entering college from the schools studied are not a highly selected group.

Johnson, Geo. R.
Qualitative Elimination from High Schools. School Rev. *18*:680-694, tables and figs. Dec., 1910.
Study based upon a number of high schools in five cities and towns in three states. Statistical method.

Schmitt, Clara.
Retardation Statistics of Three Chicago Schools. Element. Sch. Teach. *10*:478-492. June, 1910.
As indicated by title. Many tabulations. Method applicable to a particular department as well as to the whole school.

Bagley, W. C.
The Scientific Method in Educational Research. Nature Study Rev. *6*:172-178. Sept., 1910.
A very clear discussion of the need of scientific investigation in this field and some suggestions as to methods.

Davenport, Eugene.
Domesticated Animals and Plants. Pp. xiv+321. Boston: Ginn & Co., 1910.
A book suited to high school uses. Discusses variation quite broadly. Should be studied by every teacher on account of general importance in biology. Many will find this brief account of variation more suited to their needs than the author's larger work.

Ganong, Wm. Francis.

Some Reflections Upon Botanical Education in America. Science, N. S. *31*:321-334. Mar., 1909.

An assertion of the dignity of teaching in comparison with investigation, and a criticism of present conditions.

Galloway, T. W., and others.

Report of the Committee on Fundamentals of the Central Association of Science and Mathematics Teachers. School Science. *10*:801-813. Dec., 1910.

Contains many sections which present the necessity of experimental investigation and the relation of such investigation to instruction in science.

Dearborn, Walter F.

The Relative Standing of Pupils in the High School and in the University. Bull. of the University of Wisconsin. No. 312. High School Series No. 6. 1909. Pp. 1-44, pl. I-VI, tab. I-V.

Follows a group of 472 students through high school and the first two years in the university. A smaller group is followed through to graduation. Statistical comparison is made between university and high school standings in general and by departments. Shows that seventy-five per cent of students maintain in the university the same relative standing as in the high school. This paper is the model and stimulus for much of the statistical work that has been done in the Middle West.

Dearborn, Walter F.

School and University Grades. Bull. of the University of Wisconsin. No. 368. High School Series No. 9. 1910. Pp. 1-59, pl. I, tab. I, II.

A painstaking and extensive examination into the subject of grading. Statistical and graphic method. Suggestive of methods whereby a teacher or a department may undertake profitable self-investigation.

Courtis, S. A.

Measurement of Growth and Efficiency in Arithmetic. Element. Sch. Teach. *10*:58-74, 177-199. Oct. and Dec., 1909.

A comparative study of arithmetical ability in grades 3 to 13, based upon carefully devised uniform tests. Many tabulations and graphs.

Courtis, S. A.

Measurement of Growth and Efficiency in Arithmetic. Element. Sch. Teach. *11*:171-185. Dec., 1910.

A continuation of the work reported in 1909, comparing results secured after the interval of a year. Almost the only instance in which the result of an investigation into the work of a school has been followed up scientifically in an effort to evaluate to the reforms introduced.

Johnson, Franklin, W.

A Comparative Study of the Grades of Pupils from Different Elementary Schools in the Subjects of the First Year of the High School. Element. Sch. Teach. *11*:63-78, fig. 1-15, tab. IV. Oct., 1910.

Shows the average standings by groups and makes possible the tracing of any pupil. Method generally applicable and the paper very suggestive.

Davenport, Eugene.

Principles of Breeding. Pp. xiii+727. Boston: Ginn & Co., 1907.

Of interest to students of education since it presents an extensive account of biological variation in a field in which concrete illustrations are more familiar than in education. Since educational variations are in the last analysis largely biological variations, the laws of variations may be transferred from one part of the field to the other.

An appendix by Dr. Rietz (pp. 681-713) on "Statistical Methods," gives an explanation of the mathematical foundation of study of variation.

ARTICLES IN CURRENT MAGAZINES.

Physical Review for December: "Absolute Formulæ for the Mutual Inductance of Coaxial Solenoids," G. R. Olshausen; "Further Studies of the Firefly," Herbert E. Ives; "The Discharge of Electricity through Gases at Various Temperatures," R. F. Earhart; "On the Question of the Motion of the Ether in a Steady Electromagnetic Field," S. J. Barnett; "A Sensitive Thermopile," B. J. Spence; "Some Calorimetric Apparatus," Walter P. White; "A Test of Calorimetric Accuracy," Walter P. White.

School World of London for December: "Superannuation of Teachers," by Fred Charles, B.A.; "Current Geographical Notes," (Illustrated), by E. R. Wethey, M.A., F.R.G.S.; "British Teachers for Western Canada," by Elizabeth W. Phillips; "School Education in Cape Colony;" "Education in Uruguay;" "Mathematics in Austrian Schools;" "The Experiments of Boyle and of Mariotte on the Pressure of Air," by G. H. Wyatt, B.Sc., A.R.C.S.; "The Teaching of Experimental Science, Especially of Chemistry," by Alex. Findlay.

Open Court for January: "Some Unpublished Letters of Tolstoy;" "Tolstoy's Philosophy" (with illustrations), Johannes Wendland; "The Religion of Mohammed," extracts selected by Count Leo N. Tolstoy; "An Execution in the Russian Political Prisons" (with introduction by Tolstoy), Leonide Semenof; "The Fish in Folk-Lore" (illustrated), Paul Carus.

Zeitschrift für den Physikalischen und Chemischen Unterricht for November: "Eine Demonstrations-Quecksilberdampf-Lampe für Unterrichtszwecke," W. Brüsch; "Zum Nachweis der Eigenschaften der Schwingungen tönender Luftsäulen," W. Merkelbach; "Die Physik der Flugmaschine," H. Jansen; "Kleine Beiträge zur Theorie und Anwendung des Rechtwinkelprismas," A. Wendler; "Einfache Rotationsapparate und andere Gerätschaften aus Walzblei," H. Rebenstorff; "Zwei Versuche zur Sulfuration der Metalle," O. Ohmann.

American Forestry for December: "Logging for Pulpwood in the Southern Appalachians," by Guy Carleton Hawkins; "The Forest Parks of New York," by John S. Kennedy; "Management of Cut-Over Lands," by George H. Emerson; "The Forests of Alaska," by R. S. Kellogg; "The Protection of Forests from Fire" (part IV), by Henry S. Graves; "Robert Perkins Bass, Governor-Elect of New Hampshire," by Philip W. Ayres; "Conservation," by C. S. Harrison; "Cabinet Woods of the Future," by O. D. Mell; "Where Forestry can be Studied;" "The Woods of the Philippines."

Nature-Study Review for December: American Nature-Study Society; "The Weather as Nature-Study," John Dearness; "Use of Weather Maps as Source Materials," C. H. Robison; "Weather Records in the Lower Grades," Fred L. Charles; "Applied Garden Lessons in a City School," Lewis M. Dougan; "Autumn Observations on the English Sparrow," Phœbe Brandenburg.

Popular Astronomy, for January: "The Harvest Moon," Arthur K. Bartlett; "The Orbit of Holden 60, B.G.C. 12696," Philip Fox; "The Universe a Mechanism," John Candee Dean; "The Visibility of Venus by Daylight," E. A. Fath; "Are Space and Time Infinite," C. H. Ames; "Dr. See's New Theory of Stellar and Planetary Evolution," Eric Doolittle; "Distribution of the Stars in Space," H. C. Wilson.

Popular Science Monthly for January: "The Smallest of the Century Plants," Professor William Trelease; "Euthenics and Eugenics," Dr. C. B. Davenport; "The Meteorology of the Future," Professor Cleveland Abbe; "Kant and Evolution," Professor Arthur O. Lovejoy; "University Reforms," Dr. Stewart Paton; "Is the Diminishing Birth Rate Volitional?" Professor Charles Franklin Emerick; "Race Suicide vs. Over-population," Dr. Scot Nearing; "The Health Instinct," Dr. James Frederick Rogers; "War and Manhood," President David Starr Jordan.

Photo-Era for January: Among the splendid illustrations in this number are the following articles: "A Camera-Tour Through Spain," William H. Phillips; "The Albright Art Gallery Exhibition," Walter E. Bertling; "Speed-Photography in Winter," C. H. Claudy; "Rescuing an Airship in Mid-Ocean," Charles H. Huesgen.

Sibley Journal of Engineering for December: "The Practical Application of Lifting Magnets," H. F. Stratton; "The Capacity and Efficiency of Storage Batteries," N. M. MacLeod; "Some Practical Observations on Illumination, II," A. G. Rakestraw; "The Cornell Aero Club's Proposed Course of Instruction," H. C. Bate, Jr.; "Careers of Engineering Graduates;" "The Engineeering Research Department of Sibley College;" "The Effect of Compression of the Economy of the Steam Engine," R. C. Carpenter.

BOOKS RECEIVED.

Elementary Geometry, Solid, by John C. Stone and James F. Millis. vi+158 pages. 15x20 cm. 1911. Benj. H. Sanborn & Co.

Elements of Plane Trigonometry, by Robert E. Moritz, Professor of Mathematics, University of Washington. xiv+361+91 pages. 16x23 cm. 1911. $2.00. John Wiley & Sons.

A Text-book of Botany for Colleges and Universities, by J. M. Coulter, C. R. Barnes H. C. Cowles. Vol. I, Morphology and Physiology. viii+483+L. New York, 1910. American Book Co.

Elementary Course in Graphic Mathematics, by Matilda Auerbach, Ethical Culture High School, New York City. iv+54 pages. 12x18 cm. Allyn & Bacon, Chicago.

The Carnegie Foundation for the Advancement of Teaching, Academic and Industrial Efficiency, Bulletin No. 5, by Morris L. Cooke. vii+134 pages. 18x25 cm. Merrymount Press, Boston.

Industrial Arithmetic for Girls' Trade Schools, by Mary L. Gardner and Cleo Martland. xiv+150 pages. 13x18 cm. D. C. Heath & Co., New York.

Textiles, for Commercial, Industrial Schools, by William H. Dooley, Principal Lawrence (Mass.) Industrial School. xvi+221 pages. 14x21 cm. D. C. Heath & Co., New York.

Commercial Geography, by Edward Van Dyke Robinson, University of Minnesota. xlviii+455 pages. 15x20 cm. Rand, McNally & Co., Chicago.

Design and Representation. A Handbook for Teachers. 34 pages, 53 drawings and illustrations. 14x21 cm. New York State Education Department.

BOOK REVIEWS.

Academic and Industrial Efficiency. A report to the Carnegie Foundation for the Advancement of Teaching, by Morris Llewelyn Cooke. Bulletin number five. The Merrymount Press, Boston.

The investigations reported in this bulletin were made partly because of the large and new problems which have comparatively recently appeared in the rapid development and change in the American College and University and partly too, on account of the criticisms which have been made by leading business men concerning the value of university training in a successful business career. The report was made by one outside of the teaching profession, one whose line of work is with the study of the efficiency of industrial institutions.

In making the investigation the department of physics was chosen because it was believed that conditions found there would be nearer those of to-day than any other department of older standing. The institutions investigated were: Columbia University, Harvard University, Princeton University, Williams College, Haverford College, University of Wisconsin, Massachusetts Institute of Technology, and University of Toronto. The report is divided into two parts, Part I being given to such heads as general observations, general type of organizations, no present gauge to efficiency, the college teacher as a producer, research, the economical use of buildings, functional activities, financial administration, physics department administration, student administration.

II contains the results of Mr. Cooke's investigations put into tabular form with explanatory paragraphs. The titles of the tables are as follows: Valuations, expenditures, etc., data concerning imbreeding of teachers of physics, data concerning salaries of teachers of physics, percentage of salary

paid to each grade of teacher, disposition of time of individual teachers of physics, analysis of disposition of time of teachers of physics, money value of the time of teachers of physics, data concerning buildings, cost of maintenance, etc., whole cost of teaching physics, cost of teaching physics per student-hour, an analysis of teaching by departments, summary of teaching, summary of expenses, teaching and expense contracted, size of laboratory, lecture and recitation sections.

The bulletin is a comprehensive and exhaustive report from the point of view of a business man. It would be well for trustees of colleges, officers, and teachers to make a thorough study of the report, thus being better able to bring about a more amicable relation between the teaching profession and the business man. C. H. S.

Textiles, for Commercial and Industrial Schools, by William H. Dooley, Principal Lawrence (Mass.) Industrial School. xvi+221 pages. 14×21 cm. D. C. Heath Co., New York.

The publication of this book has been timely. It is undoubtedly the best of the kind in print. It was written primarily to meet the demand and needs of young people who are attending vocational schools, or to help those who are just beginning to learn the textile or kindred trades. It is written in such an attractive style that anyone not particularly interested in textile literature would become enamored with it after reading a few pages. The book is a compendium of textile matters. One may be able to secure a good idea of the latitude of the book from the names of the chapters. Beginning with the first there are chapters on: Fibers, wool-sorting, remanufactured material, worsted yarn, woolen yarn, weaving, dyeing and finishing, woolen and worsted fabrics, cotton, manufacture of cotton yarn, thread and cotton finishing, knitting, lace, cotton fabrics, flax, hemp, silk, principal fabrics, artificial silk, and substitutes for cotton. There are 28 half-tones illustrating the methods and machines used in manufacturing textile products. The type is large and clear; the principal paragraphs beginning with boldface type. Mechanically the book is well made and will stand rough usage. Those in charge of commercial and industrial schools will make no mistake if this book is used in their courses. C. H. S.

Industrial Arithmetic, for Girls' Trade Schools, by Mary L. Gardner and Cleo Murtland. xiv+150 pages, 13×18 cm. D. C. Heath & Co., New York.

As vocational courses in our schools increase, texts must be written and published to meet the demands of these schools. The publishers of Industrial Arithmetic were keen enough to understand that there would be a call for just such a book as this; so placed it on the market early.

A good working knowledge of common school arithmetic is necessary for the understanding of this book. The authors of the text believe that "emphasis should be laid upon the content of the problem, its bearing upon the trade work or upon the subject under discussion." They have, therefore, selected only those problems which are alive and full of interest. The problems cover a wide range of topics so the book may be used in classes of girls preparing for almost every trade in which girls or women alone work. In the contents one finds parts devoted to millinery, sewing, buying and selling, factory sewing, sample mounting and novelty work, incomes, bills and receipts, problems on textiles, and industrial and civic problems. An excellent feature about the book is that there is no list of answers or results given, the pupil being taught to rely upon his own powers to solve correctly the problems.

The workmanship on the book is of the best, type clear and matter well arranged. It undoubtedly will have a large sale. C. H. S.

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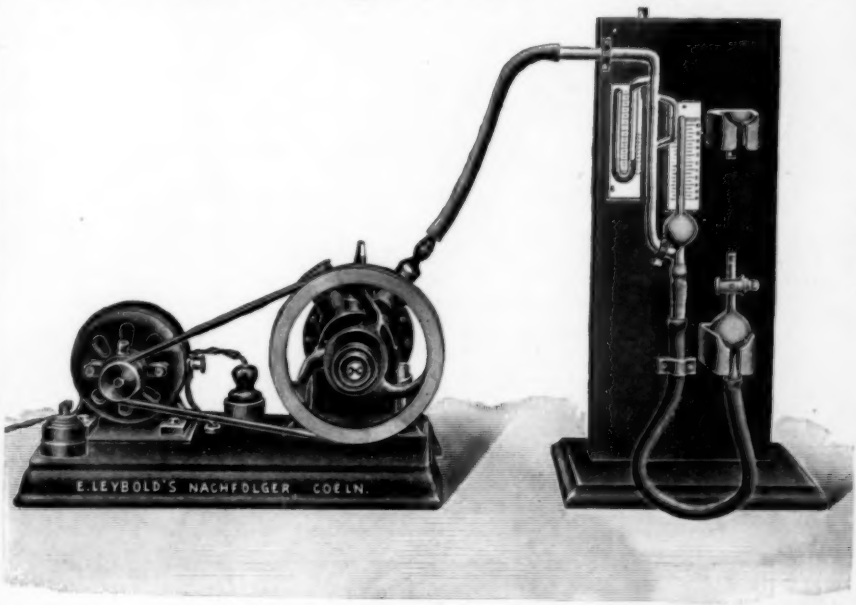

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Domesticated Animals and Plants, by E. Davenport. Pp. xiv+321. Boston: Ginn & Co. 1910. $1.25.

The title of Professor Davenport's new book might lead one to expect merely an account of the varieties of domesticated animals and plants and of their origin. It is in fact much more than that. Part II, constituting the last hundred pages, does indeed "aim to sketch briefly * * * the history of domestication and to indicate * * * the specific wild race to which each domesticated form is supposed to trace," so far as possible, and these facts are now for the first time brought together in a form that fits them for high school use. This is a valuable feature.

Yet greater value attaches to Part I, which includes a discussion of variation, heredity, selection, and the associated phenomena which form the basis of both domestication and evolution. The book is opened by general chapters on the need of domestication, origin from the wild, and the process of domestication. Then follow ten chapters on such subjects as variation, natural selection, unit characters, and their transmission, heredity, and systematic improvement, in which these subjects are presented with remarkable clearness. The dynamic viewpoint is everywhere prominent; it is of living things that the author writes and not of their dead shells.

In the field of botanical and zoölogical instruction the book will certainly illumine very many dark places for the teacher as well as for the pupil. Information on these subjects has been sadly lacking among teachers. The tendency of our advanced courses of instruction has been to turn out teachers who organized their courses of instruction in secondary schools around an evolutionary series of animals or plants because they knew no other way. At the same time these teachers were without any effective knowledge of the dynamics of evolution because they had no first-hand knowledge of variation and heredity, which are the phenomena with which evolution works. This information has not been available either in the texts or in the general courses of instruction.

Professor Davenport has performed a distinct service to biological pedagogy in thus bringing together in usable form a great body of material existing formerly only in scattered and technical papers, and of whose existence secondary school teachers were in part unaware.

Until there are some very far-reaching changes in the ideals and organization of high schools it is not probable that there will be many schools that can offer courses in which this book may be used as a text, but all schools offering biology in any form should have it at hand as a reference work. The book is not too difficult for any high school pupil who is interested in its subject. It may be confidently expected that many pupils will get from this book their first notions as to why botany or zoölogy is worth while in the work of the world, and possibly the stimulus to farther study in biological fields.

Aside from its direct value in instruction the book carries certain values in the way of by-products that must be mentioned. In the study of reproduction, heredity, progression, and degeneracy the relation of the facts presented concerning plants and the lower animals to similar facts and conditions in human society is so close that the implications can scarcely fail to be recognized by the pupils. In this way much information of sociological value will be absorbed and some of it upon subjects very difficult of approach in direct instruction.

The book is one of which no teacher can afford to be ignorant.

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American Men of Science, a biographical dictionary edited by J. McKeen Cattell. Second edition. New York, The Science Press. 1910. Pp. vii+596.

The man of science is deeply interested in the scientific achievements of his contemporaries, and, like most other human beings, he is inclined to talk about his objects of interest. His scientific training tends to lead him to make an effort to see things in their true light and to speak frankly and fully in reference to the results of his study. When he considers the work of his colleagues he generally finds the problem a very complex one, especially when the comparative standing of a large number of men is involved. The number of facts to be considered is so large that a single observer scarcely hopes to arrive at a very close approximation to the truth. In view of this fact the editor of the present work enlisted the coöperation of one hundred and twenty men of eminent standing in their subjects to bring about a selection of "the thousand leading men of science," whose work lies in the following twelve fields: mathematics, physics, chemistry, astronomy, geology, botany, zoölogy, physiology, anatomy, pathology, anthropology, psychology. Stars are added to the subjects of research of those men who came within this thousand of the two different efforts to secure such list.

While the resulting list may involve inaccuracies, it would appear a clear case of arrogance if one man should undertake to point out a number of these, in view of the limitations of a single individual and the great extent of the problem. The average opinion of the ten men who made the selection in each of the given twelve fields appears very much more reliable than that of a single individual, and tends to remove many elements akin to "the personal equation." Hence we may say that we have here a list of men who are stamped by their colleagues with a mark of distinction which may be regarded as much more reliable than the Ph.D. degree from one of the best institutions, and as indicating attainments of a higher order. As many of our leading institutions hesitate to appoint men as instructors who have not secured the Ph.D. degree from a good institution, it seems only reasonable to expect that in some institutions of the highest standing instructors will not be advanced to professorships in the fields here represented until after they proved themselves as worthy.

The book before us has many elements of value in addition to the list to which reference has been made. It gives a brief biographical sketch of a very large number of the American men of science, together with the address on January, 1910. These sketches relate to practically all scientific men who are connected with the higher institutions, and thus they furnish a convenient method to obtain some reliable data as regards the careers of these men. The volume closes with two statistical studies relating mainly to the thousand leading men of science and their distribution as regards states and institutions. The data given as a result of these studies are highly interesting to all educators, but especially to those who are in close touch with the stronger universities.

It needs scarcely be added that some of these results are only of much significance as elements of further study. For instance, the table on page 591, headed "The Scientific Strength of the Leading Institutions," takes into account only the men who come within the first one thousand leading men of science, while the others are completely neglected. As a matter of fact, some of the latter do a great deal toward advancing scientific work, and this neglected class includes sometimes names of the highest local prominence in scientific activity. It is to be hoped that the present work will tend to throw light on existing conditions and to clarify the atmosphere so as to create a higher appreciation for honest scientific work and a lower one for mere words.

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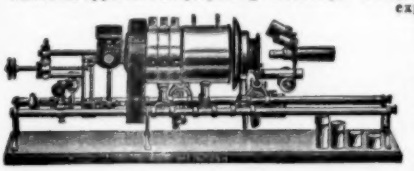

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